America's Premier Aeronautical Magazine

AERO DIGEST

INCLUDING
AVIATION ENGINEERING

FEBRUARY, 1950
50 CENTS

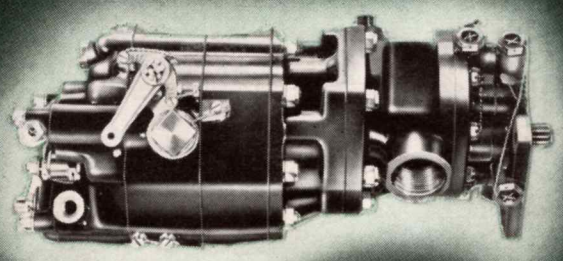
WASP MAJORS POWER THE NEW DOUGLAS GLOBEMASTER

Douglas' new military transport, the C-124 Globemaster, is the largest production transport in the U. S. Air Force. Able to carry a payload of 50,000 pounds over effective ranges, it can carry 200 troops and their field equipment. Virtually all military vehicles or wheeled field guns may enter its 10,000-cubic-foot cargo space through the clamshell doors.

Pilots of these long-range, 175,000-pound, giant aircraft have at their command 14,000 horsepower developed by four Pratt & Whitney dependable Wasp Majors.

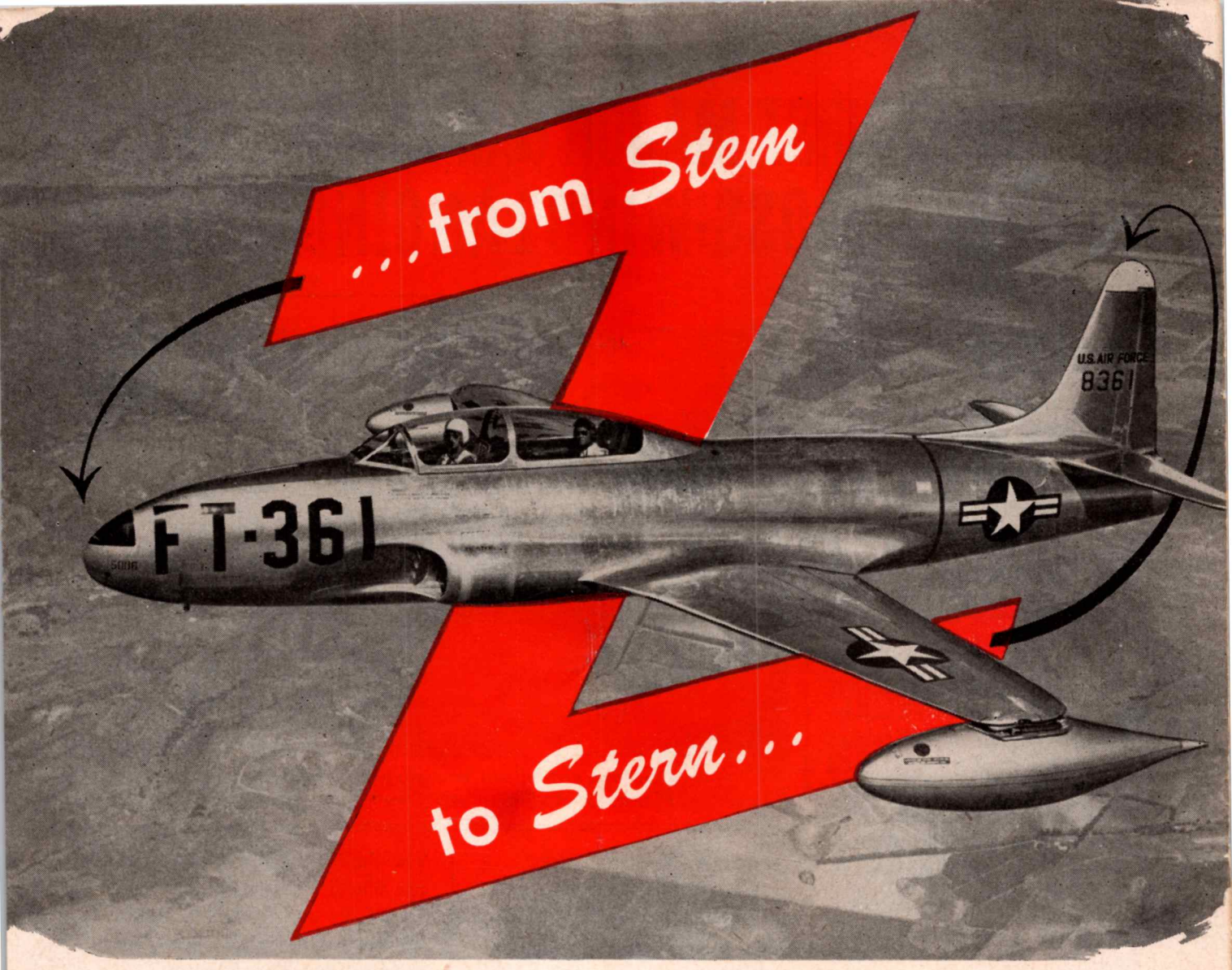
PRATT & WHITNEY AIRCRAFT
EAST HARTFORD, CONNECTICUT
ONE OF THE FOUR DIVISIONS OF UNITED AIR

TURBINE CONTROL — designed, developed and manufactured for the WESTINGHOUSE jet engine and used on the NAVY BANSHEE



HOLLEY
Carburetor Co.
DETROIT 4

FOR HALF A CENTURY — ORIGINAL EQUIPMENT MANUFACTURERS FOR THE AUTOMOTIVE INDUSTRY



T-33...AMERICA'S FIRST JET PROPELLED TRAINER is equipped with L.P* parts by ZENITH!

● The new "Shooting Star", a two-seat counterpart of the famed Lockheed F-80 jet fighter plane, will speed the training of both aviation cadets and seasoned veterans in the operation of new jet tactical aircraft.

And, as in more and more of the most modern aircraft produced today, ZENITH skill in L. P.*...low-pressure lamination...was called upon to complete an ensemble of unsurpassed strength, power and *safety*.

America's leading aircraft manufacturers have long since learned that ZENITH L. P.* Fiberglas lamination can be depended on to perform... and PRODUCE.

No plant in this country can surpass ZENITH in equipment, efficiency and ECONOMY. In L. P.,* it is practically a "MUST" to find out what ZENITH can do for you TODAY!

OTHER AIRCRAFT EQUIPPED BY ZENITH

Bell • Boeing
Chance-Vought
Consolidated-Vultee
Curtiss-Wright
Douglas • Fairchild
Martin • McDonnell
Republic

●

L.P.* LOW PRESSURE LAMINATION

ZENITH PLASTICS COMPANY

1548 W. 135th STREET • GARDENA, CALIFORNIA • PLymouth 4-2934

CAPITAL IS FIRST MAJOR U.S. AIRLINE TO USE GOODYEAR CROSS-WIND LANDING WHEELS

First Commercial Installation on New Super DC-3's For Capital Fleet

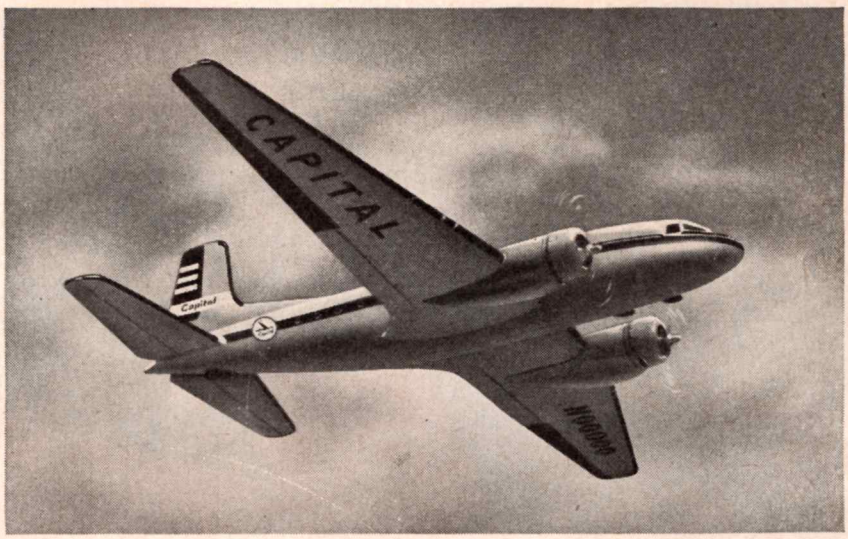
WASHINGTON—Capital Airlines has just announced that their new Super DC-3's will be the first commercial airliners in the United States equipped with the new Goodyear Cross-Wind Landing Wheel. This pioneer step by Capital foreshadows a new phase in commercial aviation.

The Goodyear Cross-Wind Landing Wheel is the only device of its kind approved by the CAA for commercial twin-engined transports. It is a self-contained mechanism built into the hub of the wheel that automatically compensates for the effects of cross winds on landings and take-offs.

Use of this new wheel will permit Capital Super DC-3's to take off and land in cross winds of high velocity.

Many Other Advantages

Wide adoption of this new device will reduce the expenditure for future airports. Its use will reduce the need for multiple runways and costly duplication of instrument-landing systems, lighting and other controls by making possible the construction of single-strip landing fields.



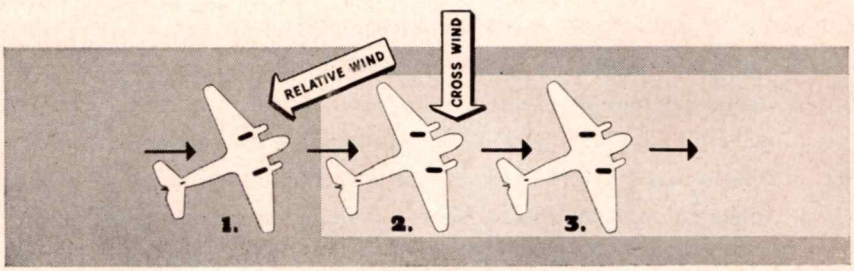
By March, Capital will be operating this new-type Super DC-3 equipped with Goodyear Cross-Wind Landing Wheels.

Can Cut Travel Time

It brings near the day when single-strip airports can be located along waterfronts or close to the heart of many cities. This will encourage greater air travel, by saving passengers millions of hours' ground travel to and from our present-day isolated airports.

The Goodyear Cross-Wind Landing Wheel is now in production for DC-3's and is also available for other aircraft. For complete information write: Aviation Products Division, The Goodyear Tire & Rubber Company, Inc., Akron 16, Ohio or Los Angeles 54, California.

New Gear Permits Landings in High Velocity Cross Winds



1. ***Final Approach***—the pilot establishes proper drift correction angle to line up with the runway. 2. ***Landing***—The instant wheels touch the ground they caster automatically, due to the ship's forward momentum to line up with direction of the runway. 3. ***Landing Roll***—Castered wheels maintain straight-line roll down runway while ship safely weathervanes into relative wind.

GOODYEAR AVIATION PRODUCTS

ESTABLISHED 1922

Vol. 60

AERO DIGEST

No. 2

INCLUDING

AVIATION ENGINEERING

FRANK A. TICHENOR
Publisher and Editor

J. E. HORSFALL
Treasurer

IRA F. ANGSTADT
Managing Editor

DR. ALEXANDER KLEMIN
Technical Editor

ARTHUR KROWS
Research Editor

KENDALL K. HOYT
Washington

PAUL H. WILKINSON
Powerplants

GEORGE O. NOVILLE
Air Cargo

ENOCH JOHNSON
Art Director

WILLIAM B. STOUT

DR. MICHAEL WATTER

DR. MAX M. MUNK
Contributing Technical Editors

Aero Digest Weekly
LETTER TO AIRMEN
KENDALL K. HOYT, Editor

February 1950

REVISTA AEREA
Latinoamericana
MANUEL BUSTILLO, Editor

★ GENERAL

Editorial: "My Dear Mr. Barney—" 5
Forty-Six Years Young 17
Transatlantic Travel Survey ..... *Thomas E. Ryan* 19
Jet Speed Is Not So Important ..... *James H. Doolittle* 22
Washington Information: The Budget Gasps for Air ..... *Kendall K. Hoyt* 30
Air Cargo—1950 ..... *Gerard E. Nistal* 34
20th Century Limited ..... *Cy Caldwell* 48

★ ENGINEERING, DESIGN, PRODUCTION

Convertible-Aircraft Congress ..... *Dr. Alexander Klemin* 20
Jet-Powered Sport Plane ..... *Paul H. Wilkinson* 24
Ramjet Laboratory 26
Geared Actuators for "Neptune" 28
Turboprop Controls ..... *George E. Knapp* 38
Notes on Pneumatics—Part II ..... *Eugene Stolarik* 44
Turbojet Combustion-Chamber Problems ..... *Dr. Stewart Way* 52
Test Flight of the "Helidyne" 64

★ AIRPORTS & AIRWAYS

Milwaukee's "Civic" Airport ..... *Francis J. Trecker* 40
Airport Shorts 42
Fire Fighting and Crash Rescue at Small Airports ..... *Jerome Lederer* 58

★ MAINTENANCE & OPERATIONS

Cybernetics and Aviation Medicine ..... *Dr. Paul A. Campbell* 33
Link for the Jets 36
Tool Rework Can Meet Production Requirements ..... *William Schweizer* 60
Maintenance Tips 47

★ DEPARTMENTS

AERO Equipment and Trade Literature Digest 77
Reaction-Powered Planes and Missiles 50
What's Up . . . and Going Up 62
Air Meetings and Events 64
Takeoffs and Turns 66
New Books 70
Names in the News 82
Index to Advertisers 110

AERO DIGEST is Indexed Regularly by Engineering Index, Inc.

Advertising

DONALD C. EMERY, *Production Manager*

Detroit
W. E. FELLOWS
714 Stephenson Bldg.
Phone: Trinity 5-8217

Chicago
L. F. McCLURE
814 North Tower Court
Phone: Superior 1585

Los Angeles
J. C. GALLOWAY
816 West Fifth Street
Phone: Mutual 8335-6

Buffalo
G. W. CAMPBELL
3214 Main Street
Phone: Amherst 1680

Boston
F. W. COLE
80 Walnut, Winchester
Phone: WI 6-1894-M

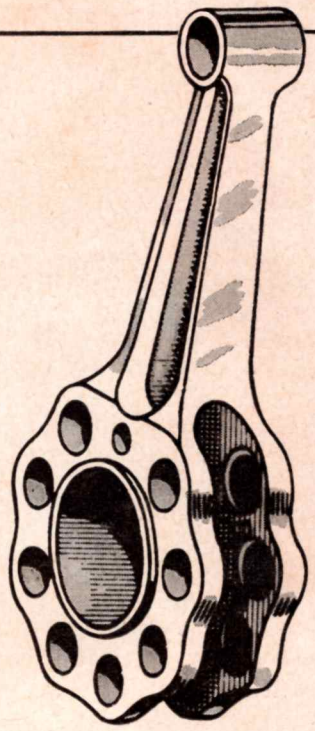
Philadelphia
T. J. HARFORD
38 Herning, Cranford, N. J.
Phone: Cranford 6-0835R

London
HART & BARTON, LTD.
139 Strand London, W.C. 2
Phone: Temple Bar 4171-2

FEBRUARY 1950. Volume 60, Number 2. Published monthly by The Aeronautical Digest Publishing Corporation. Publishing Office 34 North Crystal Street, East Stroudsburg, Pa. Editorial and executive offices: 515 Madison Avenue, New York 22, N. Y. (Plaza 3-6969). Cable AERODIG, New York, N. Y. Printed in U.S.A. Single copy 50c. Subscriptions: U.S., Spain, Central and South America, $5.00 three years, $4.00 two years, $3.00 one year; Canada $6.50 three years, $5.00 two years, $3.50 one year. All other countries $9.50 three years, $7.00 two years, $4.50 one year. When subscribing, please indicate connection with aviation industry or aviation activity. Three weeks advance notice required for subscription-address changes. Include old and new address; we cannot replace copies not delivered through your failure to notify us of address change in advance. Re-entry as Second Class Matter at East Stroudsburg, Pa. pending under Congressional Act of March 3, 1879.

COPYRIGHT 1950 BY AERONAUTICAL DIGEST PUBLISHING CORPORATION, NEW YORK, N. Y.

Precision



THE MASTER ROD,

product of the finest in precision manufacturing

AEP

Symbol of Accuracy, Efficiency and Promptness in the supply of all kinds of aeronautical equipment.

AIRCRAFT ENGINE AND PARTS CORPORATION

345 Madison Ave., New York 17, N. Y.

Grantham, Pa.

Ring Bldg., Washington, D. C.

Cable Address: Airparts, New York

U. S. Export Registration No. 2422

A Type for Every Purpose

SIOUX "RESIN BOND" Abrasive Discs

INDUSTRIAL
HEAVY FIBRE

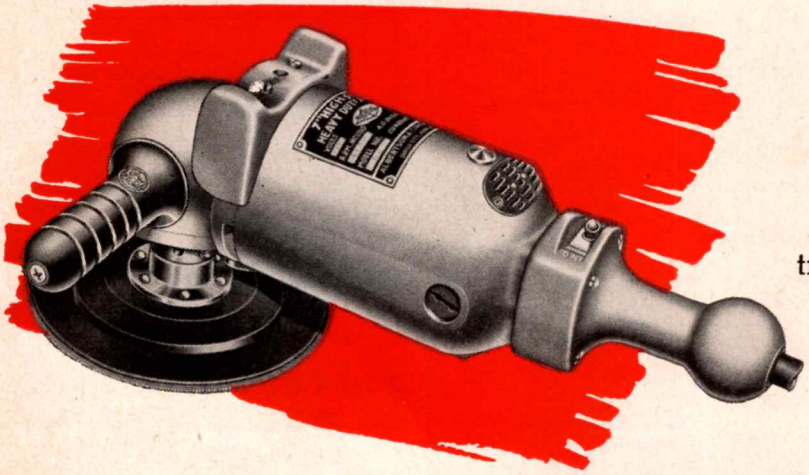
Industrial style abrasives suitable for heavy duty work, reducing welds, etc., and where heat generated is not a problem.

REGULAR
STANDARD FIBRE

Built on lighter fibre than industrial abrasives and are intended for body work where light gauge metal is used.

OPEN COAT
HEAVY FIBRE

For paint removal and cooler grinding on fenders, door panels, wood-working, etc. Non-Loading and Non-Clogging.



SIOUX HIGH SPEED SANDERS

Engineered and built for long trouble-free service. 3 Models: No. 1250—9" High Speed Heavy Duty; No. 1267—7" High Speed Heavy Duty and No. 1265—7" Special.

Sold only through Authorized SIOUX Distributors

STANDARD THE SIOUX TOOLS WORLD OVER

ALBERTSON & CO., INC. SIOUX CITY, IOWA, U. S. A.

EDITORIAL

*"My Dear Mr. Barney—"**

"THE best answer to a question about the safety of air transportation is the safety record of air transportation, not only the record as it exists but constant improvement.

"Prior to the Dallas accident American Airlines had flown nearly 11 million passengers about 5.4 billion passenger miles without a passenger fatality. Including the several accidents of 1949, the industry record for the year is 16.5 million passengers transported 500 million miles. The fatality rate for all scheduled U. S. airlines, operating overseas and domestically, was one passenger for each 100 million passenger miles flown during the year.

"The domestic record alone was 1.3 fatalities per 100 million passenger miles, the same as for the previous year. But U. S. scheduled airlines carried two million more passengers and flew a billion more passenger miles in 1949. The U. S. international airlines had a perfect record in 1949, compared with a rate of 1.06 passenger fatalities per 100 million passenger miles the year previous. Thus safety has improved in all respects.

"These are the kind of statistics that you deplore as being unconvincing, and they certainly do not answer that often-asked question, 'What's wrong with the airlines?' There is no answer to people who react positively to accidental death but consider the story of improved safety as "unintelligible mumbo-jumbo."

"Mrs. Barney's reaction—like that of other men and women—is emotional. Our only antidote is factual. The war between heart and head is one that must be waged within each individual and, interested as we are, we can only supply ammunition for the mind.

"You do not win any arguments on air safety by talking about the lack of safety in other forms of transportation. But if you, Mr. Barney, desire to live to an old age by avoiding all risks which can be measured statistically, you should center your attention on the automobile and avoid its use. For the facts indicate that you are about twice as safe in a scheduled airliner as in your automobile.

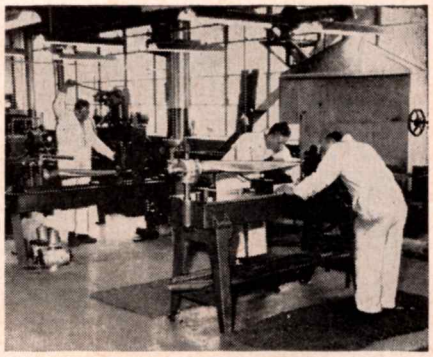
"The scheduled airlines as a group, as corporate entities and as people, thrive on safety and suffer from accidents. They are impelled to promote safety in every phase of their business not only from such a governable consideration as fear but from the more pressing need to continue in business. It is ridiculous to imply by such a question as, 'What's wrong with the airlines?' that the lines themselves are not sensitive to their responsibility toward passengers.

"Individual airlines, manufacturers, the industry's trade organizations and the Government's rule-making and policing bodies expend much of their effort to maintain safety standards already set and to improve them. These efforts have been fruitful.

"Unfortunately, although perfect safety is the goal of the airlines and their employes, this has not been achieved. It would be unrealistic to believe that air transportation will reach an accident-free peak of perfection that will not be broken. For no continuing effort involving destructible machines and fallible people ever has. This does not mean that the airline business is predicated on the probability of accident, for it is not. It does mean that the search for the ideal must be pursued grimly in the future as in the past.

"The record of what has been accomplished and the trend of that accomplishment should give any informed person confidence that he will arrive at his destination, with safety, comfort and swiftly."

* Here, Mr. Barney, is a boiling-down of the letters that have flooded my desk since your question, "What's wrong with the Airlines?" appeared on this page in January. It looks as though the airlines have a case. —FRANK A. TICHENOR



A COMPLETE PROPELLER and GOVERNOR OVERHAUL SERVICE

CAA Approved Propeller Repair Station #235

Delivering quality service for over 25 years on all types and makes of propellers for Executive, Private and Fleet Operator's planes from all over the U.S., Canada, Central and South America. A full-time staff of highly trained and experienced personnel using the best in specially designed tools and machinery, is your assurance of receiving complete dependability, performance and unequalled service. All work is guaranteed and your satisfaction is a must. Ask the man with a "Great Lakes Airmotive Orange Sticker" on his prop.

★ *Large Stock of Factory Parts Available.*
★ *Metal Blades Annealed, Repaired, Straightened and Reheat-treated.*
★ *Blades Etched, Polished or Satin Finish.*
★ *Propeller Parts Magna-fluxed and Plated.*
★ *All Governors Overhauled and Converted, are Run-in Tested.*

INQUIRIES SOLICITED — ESTIMATES GIVEN
FREE OIL CHANGE ON 100 HR. INSPECTION

THE LARGEST ORGANIZATION IN THIS AREA SPECIALIZING ON COMPLETE REPAIRS AND MAINTENANCE OF EXECUTIVE TYPE AIRCRAFT.

Featuring

AIRCRAFT-All kinds of repairs, overhauls, modifications and refinishing.

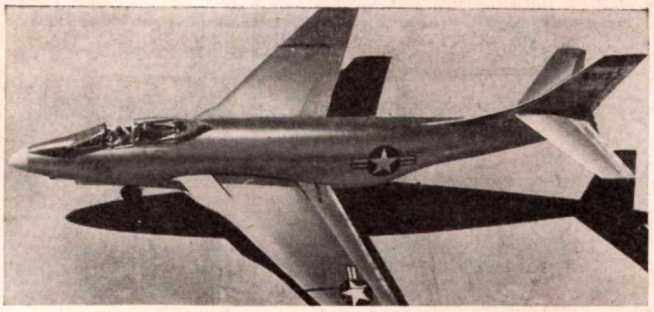
ENGINE-Repairing, top overhauling, and magnafluxing.

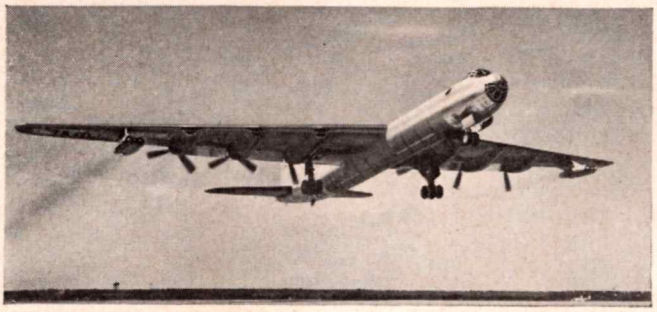
PROPELLER-The best CAA approved propeller repair station in the Midwest.

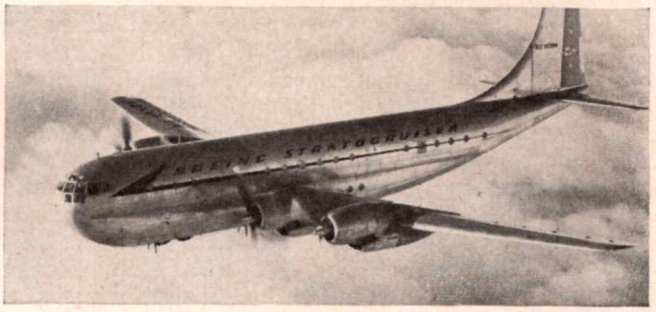
RADIO-Sales and service on all leading makes.

GREAT LAKES AIRMOTIVE, INC.

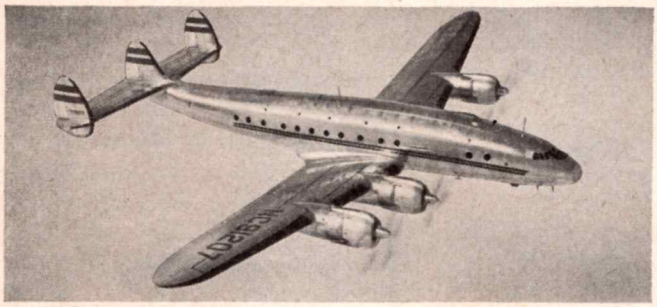
Main Hangar • Willow Run Airport
Ypsilanti, Michigan

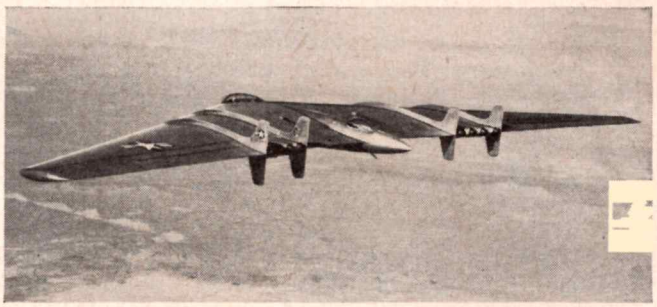


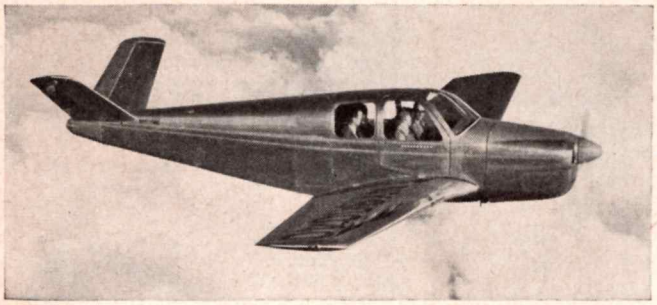


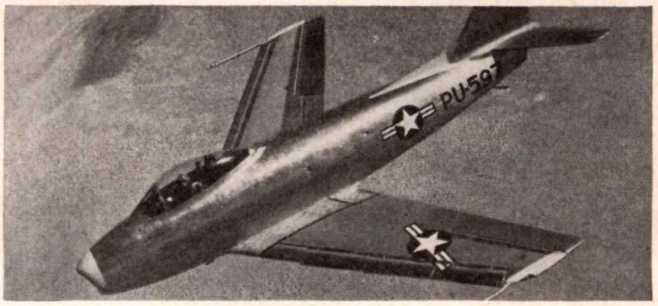


Every major U. S. aircraft builder consistently uses Kaiser Aluminum!









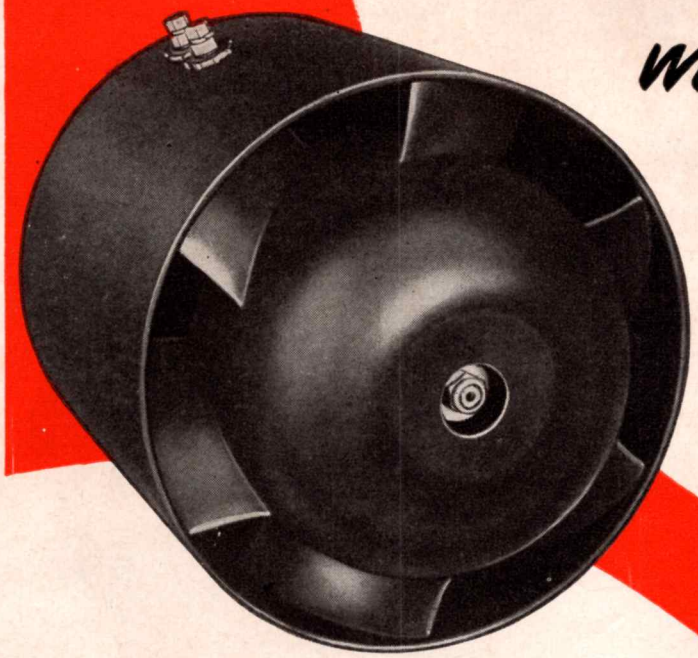
Kaiser Aluminum is produced by Kaiser Aluminum & Chemical Corporation

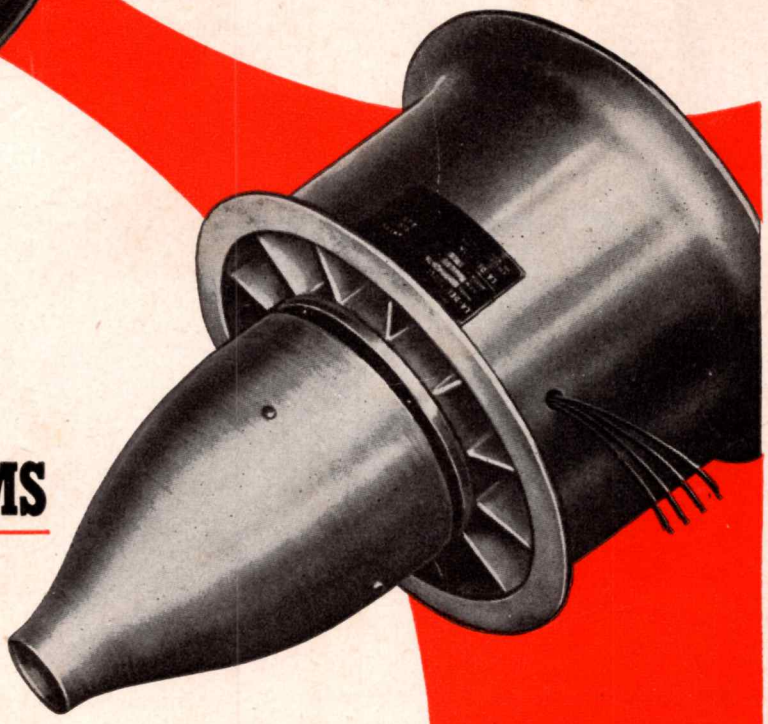
SOLD BY KAISER ALUMINUM & CHEMICAL SALES, INC., KAISER BUILDING, OAKLAND 12, CALIF. . . . OFFICES IN:
Atlanta • Boston • Chicago • Cincinnati • Cleveland • Dallas • Denver • Detroit • Houston • Indianapolis • Kansas City • Los Angeles
Milwaukee • Minneapolis • New York • Oakland • Philadelphia • Portland, Ore. • Rochester, N. Y. • Seattle • Spokane • St. Louis
Wichita • EXPORT OFFICE, OAKLAND, CALIFORNIA • WAREHOUSE DISTRIBUTORS IN PRINCIPAL CITIES

SAVE WEIGHT, SPACE and POWER

with **JOY**

AXIVANE* FANS





Specially Designed for AIRCRAFT VENTILATING SYSTEMS

JOY AXIVANE FANS answer perfectly the aircraft industry's need for a light, compact fan in a wide selection of sizes, ranging up to types with the capacity needed to service the largest airplanes. High efficiency results from the JOY vaneaxial construction, which permits high volumes and pressures with minimum power consumption.

JOY Fans for aircraft ventilating systems are available in 12 standard models, ranging in air output from 65 to 4400 CFM at 1" to 6.5" water-gauge pressure. Weights range from 5 to 51 lbs.; sizes from 3½" to 14" in diameter; and power input from .04 to 7.5 hp. Special sizes to meet *your* individual needs are available to order . . . *write for bulletin.*

Consult a Joy Engineer

* *Registered U. S. Patent Office*

W&D A2274

JOY MANUFACTURING COMPANY

GENERAL OFFICES: HENRY W. OLIVER BUILDING · PITTSBURGH 22, PA.

IN CANADA: JOY MANUFACTURING COMPANY (CANADA) LIMITED, GALT, ONTARIO

VHF Transmitters • H. F. Transmitters • Radio Control Panels • Antennas • Indicators Automatic Radio Compasses • Marker Beacon Receivers • Announcing Systems VHF Communication and Navigation Receivers • Inter-Communication Systems H. F. Receivers • Radio-Magnetic Indicators • Ground Controlled Approach Landing Systems • Flightweight Personal Plane Radios • VHF Omni-Directional Range Systems

BENDIX RADIO

REG. U.S. PAT. OFF.

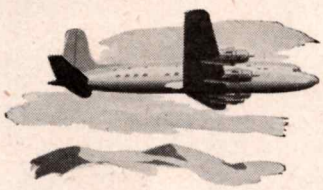
Whatever the Plane or Purpose . . .

Bendix Radio

...and still we're seeking final answers!

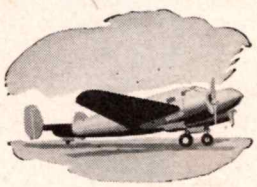
You can't sit on your hands in the aviation business. The phenomenal growth of the industry has come from its inherent belief that "there is always a better way". That is why Bendix Radio devotes as much time and thought to future products as to present production. And results have amply proved the wisdom of this policy. Basic advancements in VHF and UHF radio, and in GCA, in omni-directional equipment and other navigation aids, have firmly established Bendix Radio as the leader in *thinking* as well as *doing* in its highly specialized field. If you are looking for the latest in airborne or ground radio equipment, better check with Bendix Radio. After all, it's just good judgment to *look to the leader for leadership.*

One of the world's busiest planes—this flying laboratory in which Bendix Radio research engineers flight-test every new idea in aviation communication and navigation.



PERFORMANCE

Every major airline relies on Bendix Radio communication and navigation equipment—a preference based on sterling performance under every conceivable flight condition in all parts of the world.

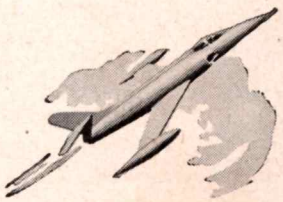


FLEXIBILITY

Buying job-designed Bendix Radio allows you to choose for yourself, from a single reliable source, any type of installation, or any combination of equipment—because Bendix Radio builds a complete line of aviation radios.

ECONOMY

For the private flyer, Bendix Radio builds airline quality equipment at prices exactly proportioned to every job and every purse—from a small battery-operated receiver on up.



ADVANCED DESIGN

In the present defense program, Bendix Radio is engaged in helping to find answers to completely new problems. Bendix Radio builds equipment for America's newest Air Force planes.

is the Choice

BENDIX RADIO DIVISION of
BALTIMORE 4, MARYLAND

Bendix
AVIATION CORPORATION

Export Sales: Bendix International Division,
72 Fifth Avenue, New York 11, New York

P.S.
Our VHF Omnidirectional Range Navigation system is a fine example of what's new in aviation radio.
Write for booklet and get up-to-date on this great development.

REEVES ARMY TWILL

FOR UNIFORMS THAT MEAN BUSINESS ON ANY JOB

YOU'RE sure of three things with uniforms and work clothes of Reeves Army Twill —*greater economy, increased morale and better company representation*. Your men look smart in Reeves Army Twill—and they *stay* looking smart. For every yard of longer-wearing Reeves Army Twill is Sanforized*, vat-dyed and made only of the highest quality cotton. Uniforms snap back—fresh, crisp and new-looking even after repeated washings and long, hard wear. Look for the Reeves label when you buy—it means *quality*.

*Residual shrinkage less than 1%

Uniform illustrated manufactured by Unitog Mfg. Co., Kansas City, Mo.

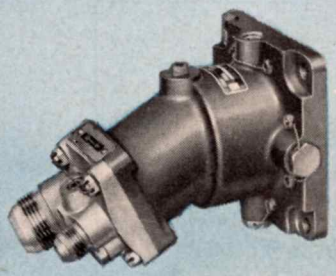
REEVES BROTHERS, Inc., 54 Worth St., New York 13, N. Y.

REPRESENTATIVES IN: *Akron • Atlanta • Boston • Chicago • Dallas • Los Angeles • Philadelphia • Portland, Oregon • St. Louis • Montreal • Toronto*

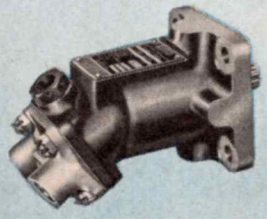
Only VICKERS Hydraulic MOTORS

(PISTON TYPE—CONSTANT DISPLACEMENT)

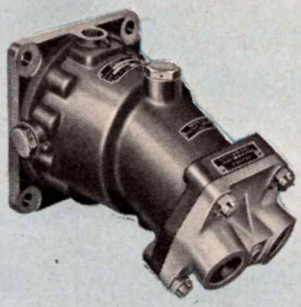
Have All These Advantages



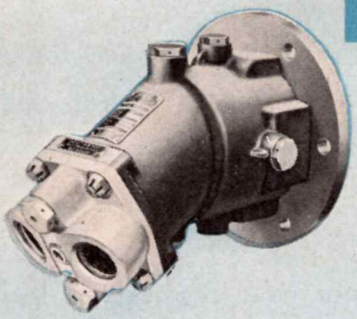
Vickers Model MF-3911 Series
for 3000 psi



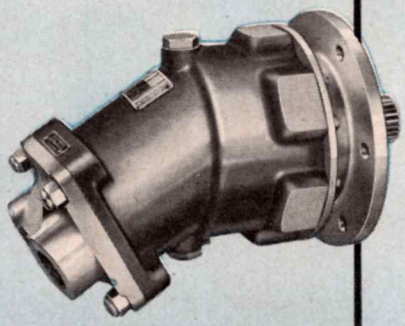
Vickers Model MF-3906 Series
for 3000 psi



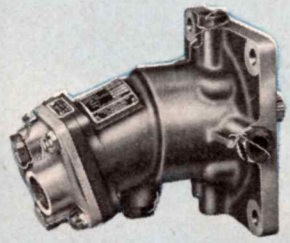
Vickers Model MF-3913 Series
for 3000 psi



Vickers Model MF-3915 Series
for 3000 psi



Vickers Model MF-3918 Series
for 3000 psi



Vickers Model MF-3909 Series
for 3000 psi

EXCEPTIONAL HORSEPOWER TO WEIGHT RATIO

•

LOW INERTIA OF MOVING PARTS

•

CAN BE STALLED INDEFINITELY WITHOUT DAMAGE

•

WIDE VARIETY OF MODELS FOR PRESSURES TO 3000 PSI

Many difficult aircraft power application problems are being solved most satisfactorily by using these hydraulic motors to produce highly efficient rotary motion.

Vickers Aircraft Hydraulic Motors have a very high horsepower/weight ratio . . . some models deliver as much as 2.5 hp per lb. No other motors pack so much power in so small a space. Because of the low inertia of moving parts, these hydraulic motors can be started, stopped and reversed almost instantaneously . . . making them particularly well suited for positioning devices where accurate control is needed. No clutches or brakes are required as these Vickers motors can be stalled indefinitely in any position without damage. Starting or stalled torque can be greater than running torque if desired. They will not cause radio interference.

Vickers (piston type constant displacement) Hydraulic Motors are inherently simple and rugged, with resulting long life and minimum maintenance. They are easily installed and widely adaptable. Write for Bulletin 49-53, "The Most Complete Line of Hydraulic Equipment for Aircraft."

VICKERS Incorporated

DIVISION OF THE SPERRY CORPORATION

1458 OAKMAN BLVD.

Detroit 32, Michigan

Engineers and Builders of Oil Hydraulic Equipment Since 1921

150 MILLION DOLLARS ★ ★ ★ ★ WILL BE SPENT

In 1950 by

ARGENTINA	COLOMBIA	GUATEMALA	PANAMA	SALVADOR
BOLIVIA	COSTA RICA	HAITI	PARAGUAY	SANTO DOMINGO
BRAZIL	CUBA	HONDURAS	PERU	URUGUAY
CHILI	ECUADOR	NICARAGUA	PUERTO RICO	VENEZUELA

REVISTA AEREA, the only Spanish-language aeronautical trade-paper published in the United States, is the one publication that guarantees you complete coverage of all key aviation personnel in Latin America.

This magazine has been the one authoritative voice for America's aviation industry, "south of the border". REVISTA AEREA is used ***month after month by*** those ***key people*** who influence the purchase of aeronautical products in Latin America.

Since World War II, these countries have skyrocketed their aero-industry to mammoth proportions—today they represent a MULTI-MILLION DOLLAR MARKET!

You must keep in touch with this tremendous market by impressing upon your readers, ***month after month,*** the identity of your firm and the products you manufacture. May we suggest that you add REVISTA AEREA to your Advertising Schedule in 1950!

REVISTA AEREA LATINOAMERICANA

515 MADISON AVE., NEW YORK 22, N. Y.

F-80

F-90

T-23

P2-V

LOCKHEED'S Parade of Stars...

F-94

CONSTELLATION

CONSTITUTION

WHITTAKER EQUIPPED

WHITTAKER aircraft valves are standard equipment in all these LOCKHEED planes. A typical example of what engineers of one leading aircraft manufacturer think of these *outstanding* valves for every type of aircraft including military, commercial and private planes. Back of their general world-wide acceptance by aircraft engineers are long-standing records of smooth, efficient operation and unfailing dependability.

WHITTAKER sliding-gate shut-off valves for the vital fuel and engine oil systems. WHITTAKER hot air valves to control the jet engine compressed air distribution systems. Their *tested reputation* has been proved by long, hard hours of outstanding performance in the air.

WHITTAKER engineers have been working with the aircraft industry for almost a decade. Call upon this unusual background of skill and experience to help solve your aircraft valve problems.

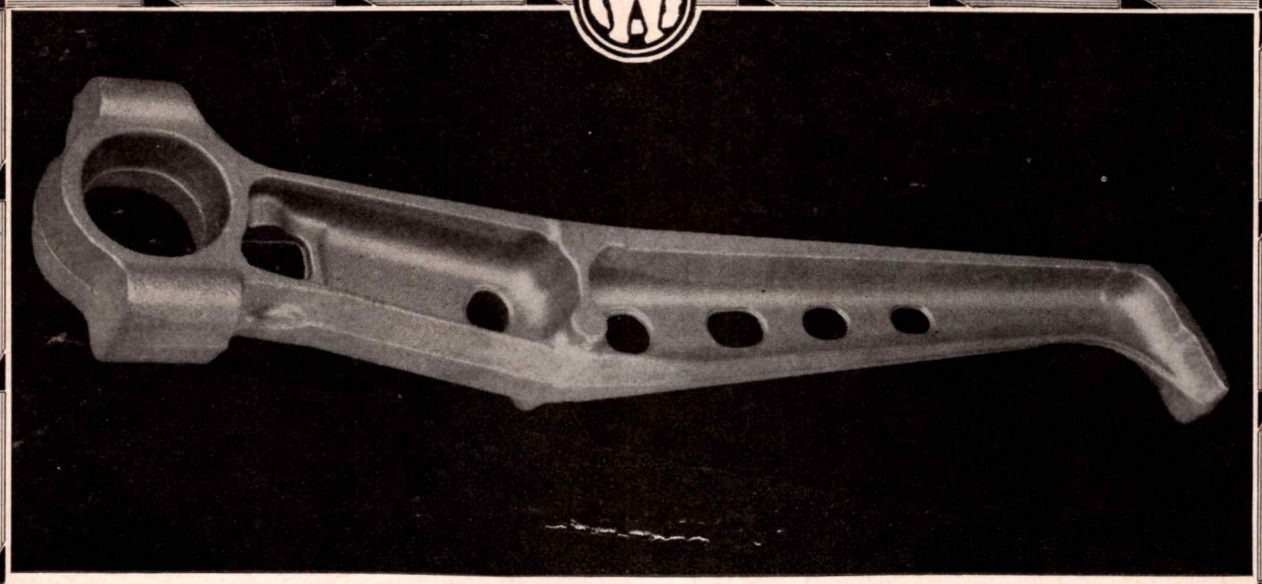
WM. R. WHITTAKER CO., LTD., 915 N. CITRUS AVE., LOS ANGELES 38, CALIFORNIA.

Whittaker

First IN DESIGN

First IN PERFORMANCE

First WITH VALVES THAT ARE FIRST CHOICE IN INDUSTRY



Another typical aircraft forging by Wyman-Gordon — with an over-all measurement of more than 45" this intricate alloy steel forging is a vital wing support for a modern military bomber. For applications of such importance the best technique known in forging practice is essential, assuring scale-free surfaces, close dimensional tolerances, uniform minimum weight and maximum strength — There is no substitute for Wyman-Gordon experience.

Standard of the Industry for More Than Sixty Years

WYMAN-GORDON

Forgings of Aluminum, Magnesium, Steel

WORCESTER, MASSACHUSETTS, U. S. A.

HARVEY, ILLINOIS - - - DETROIT, MICHIGAN

At 20,000 feet the air is not air conditioned for human consumption. It is colder, thinner and has less oxygen than required for supporting human life.

To keep cabin temperatures and pressures at the required levels, Stratos designs, develops and manufactures precision aircraft accessories of a specialized type for cooling, pressurization and air conditioning.

Pan American Airways "Gold Plate" Constellations, equipped with small, lightweight Stratos S60-1 cabin superchargers have been experiencing fewer mechanical delays and giving air travelers more flying comfort.

Other reliable Stratos designed and manufactured units are in use in new military and commercial airplanes built by Lockheed, Boeing, McDonnell, North American and Grumman. In these airplanes, the safety of the airplane and its ability to accomplish its mission depends upon the pressurizing and cooling system.

Stratos engineers are available to aviation and related industries to design and manufacture units tailored to particular requirements and to assist in the solution of any problems relating to precision high speed machinery.

You are invited to consult STRATOS for your cooling, pressurization and air conditioning requirements. Write today —no obligation, of course.

STRATOS S60-1
Cabin Supercharger

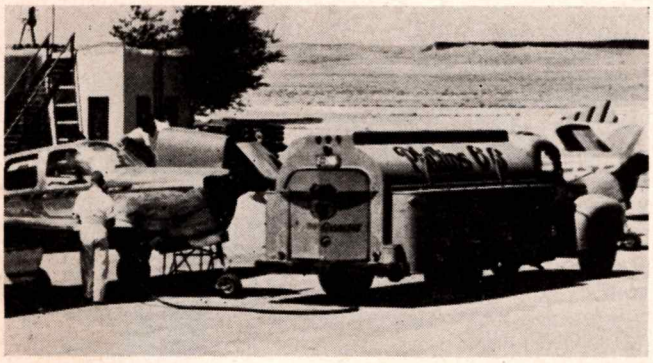
Stratos Corporation
A SUBSIDIARY OF
FAIRCHILD ENGINE & AIRPLANE CORP.

FARMINGDALE, LONG ISLAND, N. Y. • 1307 WESTWOOD BLVD., LOS ANGELES 24, CALIF.

AIR TAXI FOR ATOM SCIENTISTS!

Carco Air Service probably carries more "brains per mile" than any other airline . . . and uses Phillips *66* Aviation Gasoline exclusively.

Clark M. Carr, owner and manager of Carco Air Service, has had a colorful 22-year career . . . barn-storming, making aerial surveys, selling and servicing aircraft in South America, and serving as captain in the Army Air Corps!



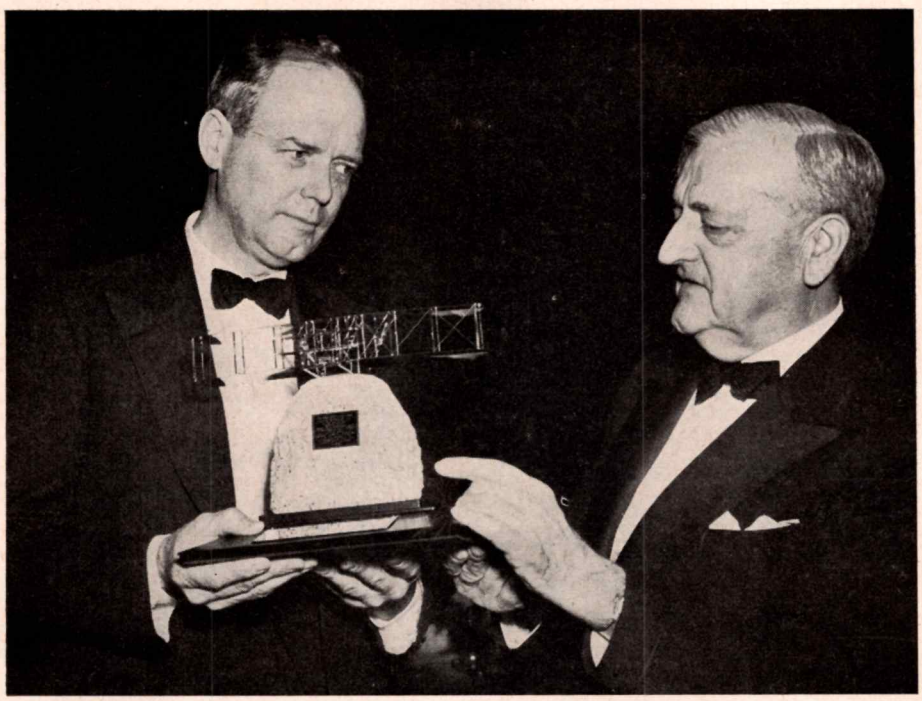
This unique "airlift" began operations in 1947 as an "on-call" charter service for the Atomic Energy Commission. It now carries an average of 1,000 passengers, plus 3,000 pounds of United States mail per month.

TOP ATOMIC SCIENTISTS are flown in and out of Los Alamos via the Carco "airlift." This miniature airline operates light, single-engine Beechcraft Bonanzas (carrying a maximum of 3 passengers per plane) over the mountains to Albuquerque. Rigid inspections, strict maintenance standards, and high-quality Phillips *66* Aviation Gasoline help Carco complete 97 per cent of their scheduled 6 round trips a day.

The same qualities which make Phillips *66* Aviation Gasoline the choice of many commercial airlines, both big and little, have made this quality fuel popular with private plane owners, too. Whether you fly for fun or business, you can rely on dependable Phillips *66* Aviation Products.

Phillips 66

AVIATION PRODUCTS



Acme

Charles A. Lindbergh (left) accepts the Wright Brothers Memorial Trophy from Louis E. Leverone, NAA president. Lindbergh warned scientists and fellow aviators that their machines are turning them into robots, threatening man's survival

FORTY-SIX YEARS YOUNG

THE 46th anniversary of man's first flight was celebrated throughout the nation in mid-December, honoring the memory of Wilbur and Orville Wright, who left, as their heritage to the world, the proved science of sustained, powered flight.

The commemoration started at 12:08 EST, Friday Dec. 2, when Thomas G. Lanphier, Jr., vice-president of the Atomic Research Corp. and past president of the Air Force Association, took off from New York on a 22,180-mile round-the-world flight via U. S. scheduled airlines, bearing a letter from the President of the U. S. to be read at the annual exercises at the Wright Memorial, Kitty Hawk, N. C., Dec. 17. Lanphier's elapsed time for the trip (4 *days*, 23 *hrs*, 47 *min*) was actually 3 minutes less than the scheduled airline time.

Other events included the issue of a memorial 6-cent air-mail stamp by the Post Office Department, bearing pictures of the Wright Brothers and their plane, and observances throughout the country by local chapters of the National Aeronautic Association and other aviation organizations, as well as the military.

National Aviation Forum. — The event of greatest significance, perhaps, was the traditional climax of aviation's birthday held in Washington, D. C. on Saturday Dec. 17. During the two days previous, representatives of practically all phases of air activity had gathered in Washington to attend a National Aviation Forum. This was sponsored by the NAA as a successor to the Aviation Clinics staged during the past six years. Delegates from all parts of the country assembled for discussion sessions where the overall theme was the " . . . need for establishing a long-range national aviation policy and means for implementing same."

Speakers included Dr. George D. Stoddard, president of the University of Illinois; Eugene E. Wilson, former president of United Aircraft Corp. and past president and chairman of the board of the Aircraft Industries Association; and the Rt. Rev. Monsignor Maurice Sheehy, of the Catholic University of America. Presiding at the meetings were Louis E. Leverone, president of the National Aeronautic Association; Dr. Leslie A. Bryan, director of the University of Illinois Institute of Aeronautics; Lt. Gen. Ira C. Eaker, USAF (Ret.) vice-president of Hughes Aircraft Corp.; and Frederick C. Crawford, president of Thompson Products, Inc.

Brewer Trophy.— One of the highlights of the Forum was the bestowal of the 1949 Frank G. Brewer Trophy, by the NAA, for outstanding contributions to aviation education. The trophy was presented to Elsie Whitlock Adams, supervising teacher for elementary education, Dept. of Public Instruction, City of Denver.

Miss Adams was cited for " . . . giving the wings of air age reality to school children by the practical and effective application of aviation to the process of education." In se-

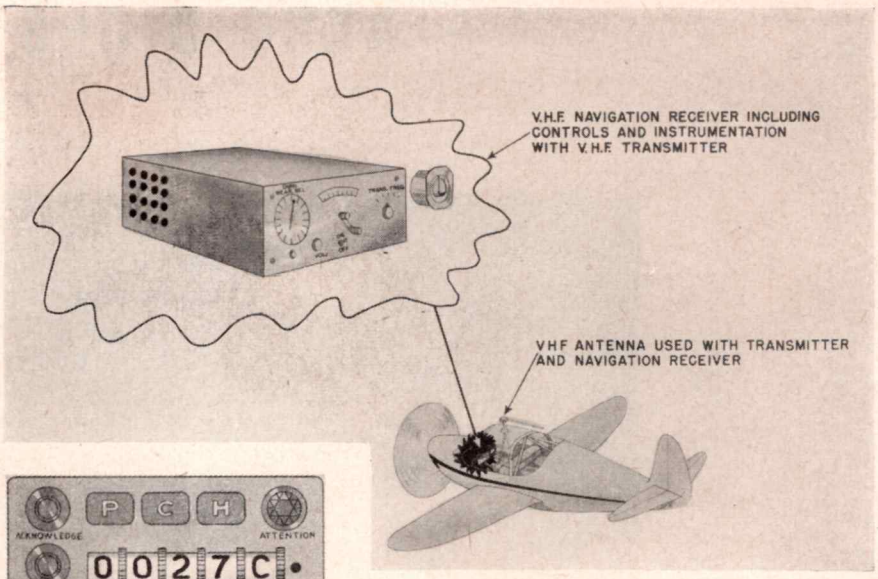
lecting her as the recipient, the award committee also honored indirectly the work of thousands of school teachers throughout the country upon whom the success of aviation education depends.

Wright Brothers Lecture. — Forum delegates and other invited guests spent Saturday afternoon attending the annual Wright Brothers Lecture, presented by the Institute of Aeronautical Sciences. This year's guests speaker was A. E. Russell, chief design engineer for the Bristol Aeroplane Co., Ltd., of Great Britain, an Associate Fellow of the Royal Aeronautical Society. Russell was largely responsible for the design and development of the Bristol *Brabazon* and the *Theseus* turboprop engine. He spoke on "Some Factors Affecting Large Transport Aircraft with Turbo-Prop Engines."

Russell first reviewed the characteristics of the propeller turbine engine immediately available for the type aircraft under consideration, and then went into an analysis of the primary aerodynamic factors determining operating efficiency and defining the geometry of the plane. This gave perspective to the main portion of his lecture which dealt with certain technical aspects relevant to the design of large aircraft.

The results of Mr. Russell's analysis as summed up in his lecture are as follows:

(1) Economic operation of turboprop engines is restricted to high altitudes and maximum power
(2) Lower noise and vibration levels of turbine engines will increase passenger comfort
(3) Ambient flight conditions have a greater influence on turboprop aircraft performance than on planes powered by reciprocating engines
(4) The wings are the only structural component in which the proportion of weight increases with a gross weight increase
(5) If wing-loading and aspect-ratio values remain constant, this rate of increase will be approximately 1½% for each 100,000-*lb* increase in gross weight
(6) As cruising speeds for large aircraft rise, the importance of gust effect at these speeds will diminish
(7) If a "long-range aircraft" is required to carry maximum payloads for shorter distances, its long-range efficiency may be seriously impaired
(8) As the proportion of payload diminishes with increased range, the weight of passenger service equipment also diminishes
(9) When long-range speed and economy are necessary in a civil transport, large aircraft must be used



Above: Basic airborne-equipment requirements for light aircraft in RTCA interim control system. Inset shows final aircraft-panel instrument for the transmission and reception of traffic-control data. Transponder transmits radio signals to ground computer which electronically checks plane's position

(10) The point has not yet been reached where maximum operating efficiency is adversely affected by fundamental technical barriers arising in the engineering profession.

Wright Brothers Memorial Trophy.— The Aero Club of Washington held its annual Wright Brothers Memorial Dinner on Saturday evening, Dec. 17. Highlighting the event was the presentation of the Wright Brothers Memorial Trophy, one of the nation's top aviation awards, to Charles A. Lindbergh for "significant public service to enduring value to aviation."

The special committee which selected the winner was composed of Louis E. Leverone, representing the NAA; John F. Victory, NACA; Admiral Emory S. Land, USN (Ret.), ATA; Admiral DeWitt C. Ramsey, USN (Ret.), AIA; William A. M. Burden, IAS; William T. Raymond, Aero Club of Washington; and James J. Strebig of Associated Press, AWA.

Several significant, but little-known facts were brought out in the Committee's statement making the 1949 award to Lindberg. These include the following:

(1) Beginning in 1936, Lindbergh made a study of military aviation in France, England, Germany, Russia and other European Countries. The information caused the late General of the Air Force H. H. Arnold to write, "Lindbergh gave me the most accurate picture of the Luftwaffe, its equipment, leaders, plans, training methods and defects that I had so far received."
(2) In 1939, he went on active military duty with the AAF to evaluate aircraft factories and research facilities in America, with respect to those he had seen in Europe. As a member of the NACA, he served as chairman of its Special Survey Committee on Aeronautical Research Facilities. The recommendations of this committee resulted in the construction of the Lewis Flight Propulsion Laboratory, at Cleveland (AERO DIGEST—Nov. 1949).
(3) After Pearl Harbor, he served as advisor to the Ford Motor Co. and to the United Aircraft Corp. In 1942, at Willow Run, he carried out a flight-research program at altitudes in excess of 40,000 *ft.* In 1944, he made a study of fighter requirements in the Pacific theatre which took him on 50 combat missions with AAF and Marine squadrons. He inaugurated a cruise-control program which increased range of AAF fighter groups by several hundred miles.
(4) For the past two years, he has worked with the USAF as special consultant to the Chief of Staff, operating with fighter and bomber groups in the U. S., Alaska, European and Pacific areas.

Collier Trophy.— A week later, as a fitting close to the celebration, the 1949 winner of aviation's highest award, the Collier Trophy, was announced. For the 15th time in its 38-year history, the Trophy was awarded to a group, rather than an

(Continued on page 99)

"Flying itself was no novelty to these travelers. Better than three out of four had flown on commercial airlines before and more than half of them had completed a previous transocean flight"

TRANSATLANTIC TRAVEL SURVEY

Personal Interviews at Gander Reveal Passengers' Likes and Dislikes about Overseas Flying

THOMAS E. RYAN
Research Manager, "Time Magazine"

IN RECENT months, the number of transatlantic air passengers has climbed faster than a jet takeoff. In 1948, 211,139 passengers took the high road over the Atlantic—up 9% over 1947's total of 194,113—and all indications showed continuing upward trends for 1949. The magic of "Europe in 12 hours" seems to be catching two-week vacationists and busy executives alike.

What kind of people are doing the bulk of the flying overseas? What are their incomes and occupations? What are their criticisms of and suggestions for the services and accommodations now being offered on these flights?

New light on these questions (and on many more like them) was revealed recently by a survey conducted by International Public Opinion Research, Inc.

The information was gathered at Gander, Newfoundland, during March, 1949. Although the study was limited to New York-bound passengers (whose flights were almost completed), approximately half were *going towards* the principal destination of their trip, and half were *returning from* their principal destination.

Passengers of the following airlines were interviewed: Air France, American Overseas Airlines, British Overseas Airways Corporation, KLM (Royal Dutch Airlines), Pan-American Airways, Scandinavian Airlines System, and Trans World Airlines. "Likes" and "dislikes" about the trip varied slightly — even on different flights of the same airlines—but the over-all response followed a pattern.

The Flying Habit

Flying itself was no novelty to these travelers. Better than three out of four had flown on commercial airlines before, and more than half had completed a previous transocean flight. As might be expected in March, 50% of the passengers were traveling for business reasons, while the other half was about evenly divided between "personal" and "pleasure" motives. In line with this proportion, passengers were predominantly male almost seven out of ten. Their ages ranged from under 20 to over 60, but with 46% in the 30-39 and 40-49 brackets.

Their annual income, too, bulked highest in the over $5000 groups. Income influences travel—*air* travel even more and, even more so, *transatlantic* air travel. While 63% of the passengers with incomes under $5000 had flown on commercial airlines before this percentage rises to 94% among passengers with incomes over $5000. In the under-$5000 group, atlantic-flight history, 37% had flown abroad previously, while the figure zoomed to 71% for passengers having incomes over $5000.

Occupation-wise, nearly half of the travelers interviewed were major business executives, or held professional or semi-professional positions; 5% were public officials or military personnel; and another 5% stated simply "businessmen." (Incidentally, over 85% of the *(Continued on page 68)*

CONVERTIBLE-AIRCRAFT CONGRESS

DR. ALEXANDER KLEMIN
Technical Editor

ON DEC. 3, 1903, Simon Newcomb proved that heavier-than-air flight was impossible. The Wrights flew on Dec. 17. Some ten or eleven years later, Jerome C. Hunsaker and I were sorting out technical files in the Department of Aeronautics at the Massachusetts Institute of Technology. We saw an article in Spanish, "El Ala Rotante de Senor Juan de la Cierva," decided that this was just a silly story and threw it into the waste basket.

When Van Baumhauer, about 1927, proposed a design, that had almost every feature of the modern single-rotor helicopter, to the Daniel Guggenheim Fund for the Promotion of Aeronautics, the reply was: "What, another helicopter! We can't have anything to do with it."

In 1940, the most celebrated aerodynamicist in the Navy Department successfully and single-handedly fought off the NACA sub committee on rotary-wing aircraft and proved conclusively that the Navy would never have any use for the helicopter!

We learn from history that we *never* learn from history; and today people say: "Convertible aircraft would be wonderful, but can they be built? It's tough enough to build an airplane or a helicopter—never mind the combination!"

If these skeptics had attended the recent Convertible Aircraft Congress held in December in Philadelphia, promoted and organized by the genial and forceful E. Burke Wilford of Philadelphia; if they had noted the enthusiasm of the large gathering; if they had seen the interest aroused among the attending military personnel, they would have ceased to scoff and stayed to cheer!

Has the Convertible a Real Sphere of Usefulness?—Two speakers in the afternoon session, over which Laurence Le Page presided, answered this question.

The first, Lt. Commander William Knapp of the Bureau of Aeronautics, discussed *Naval Uses for Convertible Aircraft.* The performance of fixed-wing aircraft always increases, as do its landing and take-off speeds. Deck space and carrier dimensions, the vagaries of wind and weather remain the same. Only the helicopter ". . . is capable of landing and taking off with relatively little concern for wind direction and strength, and the accompanying roll and pitch of the operating platform, and most important, with no requirement for landing or take-off run." But the helicopter's performance is limited. "A logical step in the aeronautical sciences is to marry these two types of aircraft and produce one with certain desired characteristics of both."

Then Commander Knapp proceeded to lay down requirements, calling for the speed of a fighter and the low-speed characteristics of a helicopter. He would, however, compromise:

> "The development of semi-direct lift aircraft will logically precede the development of high-performance aircraft capable of true hovering. The primary mission of this aircraft will be accomplished in high-speed flight, with the capability of some degree of vertical ascent or descent only as a complementary characteristic facilitating shipboard launching and recovery. In short, there might be a need for airplanes that approach the performance of helicopters, and helicopters that approach the performance of airplanes."

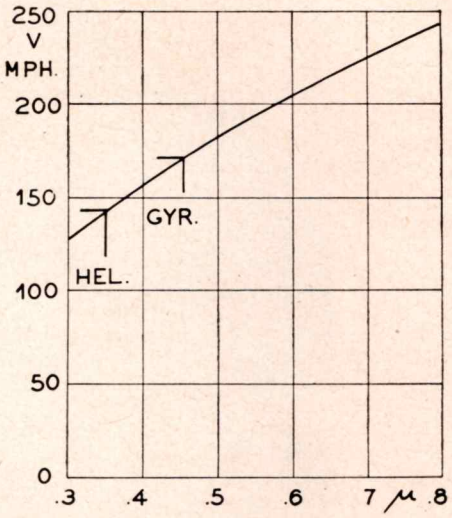


Figure 1

If "convertible aircraft," thus defined, came into being, the effect on Naval aviation would be remarkable.

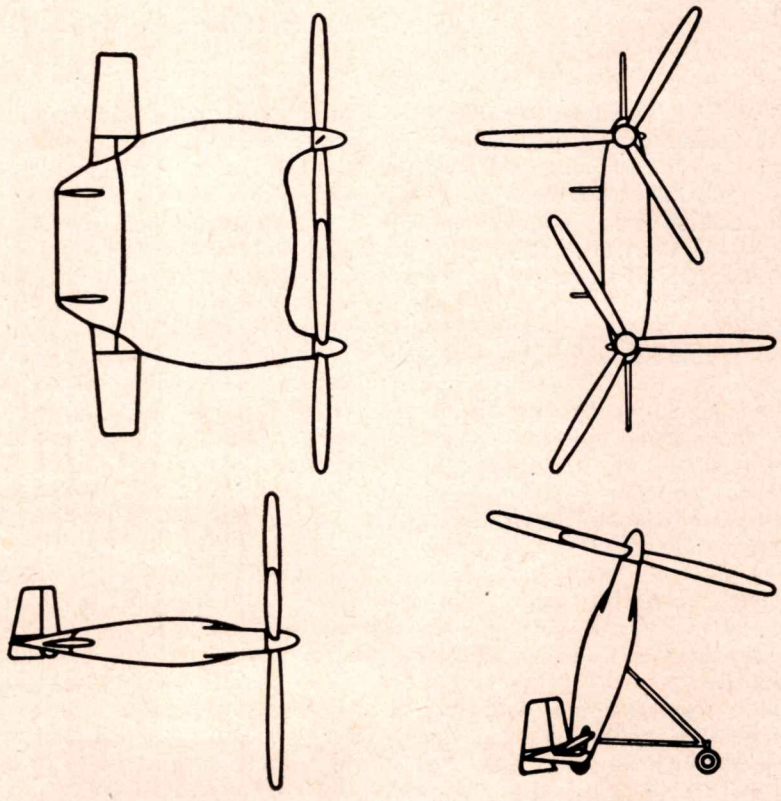


Figure 2

". . . basic changes in the present concept of sea-air warfare, new systems for deck-handling, launching and recovery would have to be worked out. Because of the elimination of the requirement for long, clear flight decks and complicated launching and arresting gear, the very form of the carrier of the future might change. Again, because of the vertical or near-vertical takeoff angle, it should be possible to launch or recover numbers of aircraft simultaneously.

"In addition to operating from aircraft carriers, it should be possible, with minor modifications, to operate small groups of aircraft from ships primarily designed for other purposes, such as tankers, freighters and troop transports. This in some cases might eliminate the necessity for the specialized aircraft carrier and still make possible control of the air, surface and subsurface in a wide radius surrounding such a ship. This is but an indication of the possible far-reaching effects of the application of convertible aircraft to Naval aviation."

There is but one remark in Commander Knapp's fine paper that one might criticize. ". . . but the Navy can and will, I believe, insist upon a very convincing demonstration of the potentiality for ultimate realization of some such requirements before entertaining the support of any proposed project in this field." This means, *Millions for a successful convertible aircraft, not a penny to make such success possible!*

The second speaker, Ronald Rohlfs of the Civil Aeronautics Administration, in his paper, *Will the Convertible Aircraft Break the Bonds of the Present Restricted Market for Private Aircraft?* brought up points that seem to have been overlooked thus far. A true convertible landing and taking off at zero miles per hour and flying really fast would be wonderful. But would its complexity be too much for the public? Its cost be prohibitive? Its maintenance be a burden? The noise of jet-driven rotor blades be a hindrance? Would it be hard to fly an aircraft having dual functions?

Evolution Not Revolution

The impossible in aviation always comes to pass. But Dr. Kurt H. Hohenemser thinks that evolution in aircraft is a surer path than revolution. His paper, *Higher Flight Speeds for Rotary Wing Aircraft by Combination With Fixed Wing*, was scholarly and solid.

He defined the *Convertaplane*. "It is generally assumed that in a convertaplane," he said, "the horizontal lifting rotors have either to be stopped in forward flight and possibly retracted into the fuselage, or that their axes have to be tilted so that they point in the direction of flight." The purpose of his paper was to determine what gain in performance might be achieved by the pure convertaplane, what gain by using a fixed wing in combination with a rotor, and, from a comparison, to see whether or not the greater complexity of the convertaplane is justified.

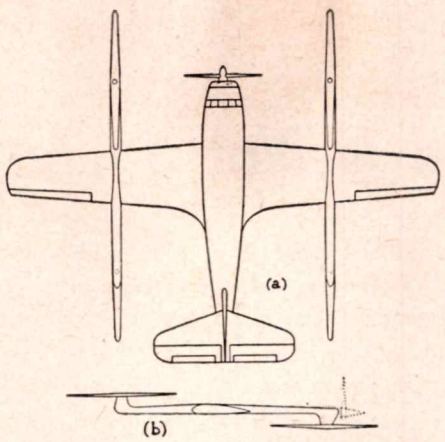


Figure 3

There are definite speed limitations for the helicopter. The first is due to compressibility; the relative airspeed on the advancing blade tip cannot exceed 550 *mph*, at least for today's airfoil. The second is stall of the retreating blade, particularly when the blade loading is high. Because of this stall, the practical advance ratio of a typical helicopter rotor is limited to μ—0.35.

For a ratio higher than 0.35, the rotor thrust vector is inclined backwards with respect to the direction of flight, and no propulsive force can be obtained for the rotor. Nor is increasing the rotor *rpm* by change-speed gearing a likely cure, because of the tip-speed limit of 550 *mph*. Conditions are better for the *gyrodyne*, in which the rotor is horizontal and propulsion comes from a conventional propeller. Where the advance ratio limit is μ—0.45, *Fig. 1* illustrates the argument graphically.

1. For a helicopter limits are μ—.35, speed—150 *mph*
2. For a gyrodyne limits are μ—.45, speed—170 *mph*
3. For the gyrodyne in combination with extra wing area equal to 6% of the rotor disk area, μ—.83 and speed —250 *mph*.

Dr. Hohenemser adds 6% of the rotor-disk area to the fixed-wing area of the gyrodyne (already equipped, as we all remember, with some fixed-wing area to support the outboard propeller); sets the fixed wing at C_L –0.6; assumes for it a reasonable L/D of 20; relieves the rotor in forward flight of much of its loading. Of course, the very high μ in a flapping rotor brings dynamic difficulties, but, still, a real advance is achievable.

A true convertaplane would give a top speed some 10% higher than the gyrodyne-fixed wing combination, and pay for it in greater complexity. The author's concluding and thought-provoking remarks were:

"These considerations indicate that, while the combined rotary wing-fixed wing aircraft requires only comparatively small modifications of present prototypes, a number of good-sized obstacles are piled up in the road of the pure convertaplane. Nevertheless, the combined aircraft is capable of attaining flight speeds which are not much below those of a pure convertaplane of equal weight and engine power, at least in the medium-speed range. Though the pure convertaplane certainly should not be forgotten as an ultimate goal for very high-flight speeds, the combined aircraft seems to be the next logical step in order to obtain flight comparable with

(Continued on page 106)

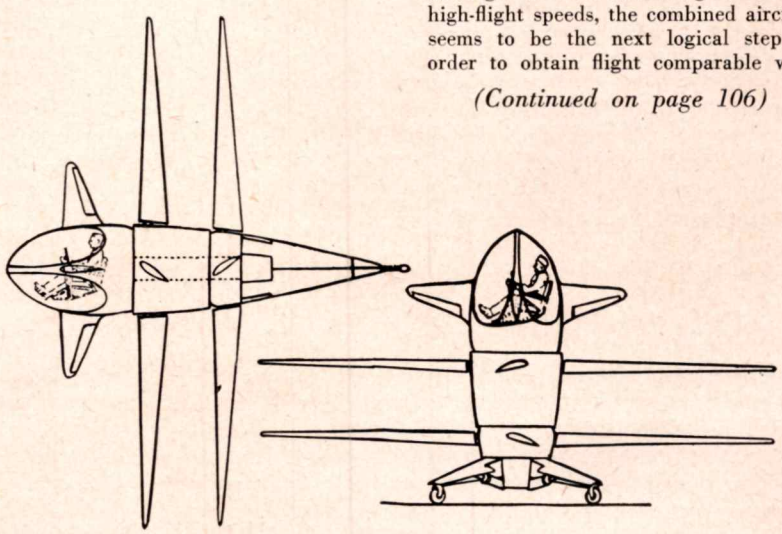


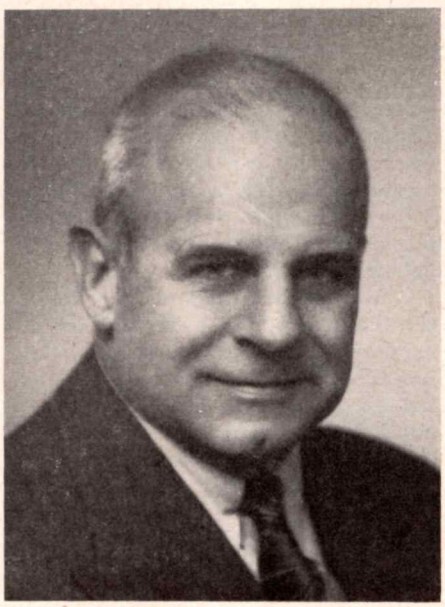
Figure 4

Guest Editorial

Jet Speed Is Not So Important!

A competent authority ventures to differ with a prevailing British notion and offers what he believes to be a more practicable approach at this time to make the commercial jet transport a reality

JAMES H. DOOLITTLE
Vice-President, Shell Oil Co., Inc.



James H. Doolittle

SOMETHING over three years ago, in London, I gave a short, impromptu talk before the Royal Aeronautical Society. The RAeS there compares generally with the Institute of the Aeronautical Sciences here, except that it is much older and far more steeped in convention and tradition. I said, in substance, that in air transportation too much importance was being given to speed. Had it not been for the inherent forbearance of the British and the fact that I was the guest of honor, I'd probably have been thrown out. My statement started a "heated discussion." Considering the proverbial British self-control, a "heated discussion" over there compares roughly with a riot here.

I went on to say that in my opinion, the future development of air transportation should proceed with emphasis as follows:

(1) ***Safety***—which must always be paramount and with which there can be no compromise
(2) ***Reliability***—meaning the ability to adhere to schedule—to fly regardless of weather conditions and to get passengers to their destinations on time
(3) ***Economy***—while the primary purpose of any airline is to give a public service, it must operate "in the black" or it cannot remain in business.
(4) ***Passenger Convenience***—this consists largely of handy schedules and the avoidance of inconvenience and annoyance on the ground—in getting to and from the airport, in handling of tickets, baggage and customs and, particularly, in prompt and courteous treatment by traffic personnel
(5) ***Passenger Comfort***—with particular reference to comfort in the air
(6) and last—***Speed.***

A self-appointed spokesman for my British audience very forcibly pointed out that, in their opinion, I had the whole thing upside down—that speed was all-important.

Even then, knowing that they could not catch up with American reciprocating-engine air-transport development, they were planning, designing, and working to play leapfrog over our conventional aircraft with a full line of gas-turbine, ultra high-speed transports. This was a sound approach from their point of view.

A major problem with jet transport aircraft on transatlantic crossings will be their relative inability to select favorable altitudes—those with minimum effective westerly winds. They must fly at high altitudes, because only there are engines relatively efficient.

★ ★ ★

There are many other problems to be solved before jet transports can be used commercially. They cannot wait around at low altitudes for their turn to land; their fuel consumption is too high. Therefore, in bad weather there can be no stacking. The traffic direction must be straight in—in turn—with no delay, as in the Berlin Airlift. This means a complete revision of traffic-control procedures.

It means also more-accurate weather forecasting. It must be proved whether or not present communications facilities can accommodate a 66 2/3% increase in cruising speed—from 300 to 500 *mph*. The effect of rough air on the passengers and on the aircraft structure at these higher speeds must be definitely established. A jet airplane must be able to slow down rapidly when it enters rough air. This means that the high-speed jet airliners must be equipped with some sort of decelerator or air brake. I flew a B-45 multi-jet bomber at Edwards AFB, Calif., last year, and, at high speeds, this type of aircraft hits rough air in a way which would be seriously discomforting to passengers.

There are many other problems yet to be solved in high-speed air transportation, and I would like to suggest that some wideawake airline shall make a deal with the U. S. Air Force to run a one-year shakedown test for it with a half dozen B-45's. If these planes were put on mail, express and cargo schedules, we could learn quickly a great deal about scheduled high-speed operations and make up, in part, the lead that our friends across the water have achieved in the development of high-speed commercial aircraft.

If I have made the problems of high-speed flight sound insuperable, then I have expressed myself poorly. The problems are there; they are difficult; but they are all

capable of solution and must be solved. The deHavilland *Comet* and its successor jet transports are destined to exercise a profound effect upon air transportation within the next ten years.

In my opinion, the principal advantages of turboprop-powered aircraft, such as the British *Mamba*-powered C-47 and the Vickers *Viscount*, lie in the relatively short-haul field. Another advantage is their ability to break in two the 200-*mph* jump from 300 to 500 *mph*. This will permit going from 300 to 400 to 500 *mph* in two increments of 100 *mph* each, thus making it much easier to solve the problems involved in the greatly increased speed of pure jet transports.

★ ★ ★

The use of turbojet aircraft not only will increase speed, but also will improve passenger comfort through reduced vibration and noise. The employment of gas-turbine powerplants, which utilize fuel having a higher boiling-range fuel, will greatly reduce fire hazard in case of a crash and will, in turn, promote passenger comfort by removing one normal fear.

Except for Canada, which has built and is now flying the prototype of the Arvo *Jetliner*, Great Britain is, as far as I know, the only nation which has a jet air-transport prototype flying or under construction.

Britain now has flying six transports to be powered by either turboprops or pure jets. These range from the giant *Brabazon*, about the size of the B-36 and grossing nearly 300,000 *lbs*, down to the *Marathon II*, a light, feeder plane designed to carry up to 22 passengers. English manufacturers now have on their books, from Great Britain's airlines, orders for some 60 gas-turbine powered planes.

★ ★ ★

The question rightly may arise why Britain is so far ahead of the U. S. in the production of commercial jet aircraft. There are three reasons for this.

First, a wartime decision. It was agreed that, because of America's greater safety from bombing and its huge industrial capacity and mass-production "know how," the major portion of allied airframes and engines for the combat units would be made in the United States. Logically, much of the development work on conventional piston or reciprocating engines was carried on in this country, while Britain concentrated on research leading toward the design, construction, and production of jet engines which were introduced there by Air Commodore Sir Frank Whittle, some two years before we started on them.

Second, Britain, immediately after the war, met with serious reversals in her attempts to build conventional commercial aircraft which could compete successfully with existing American transport planes. Therefore, the British made the obvious decision and directed their efforts toward the development of gas-turbine powered transport planes.

About the Author

IN 1922 James H. Doolittle was the first to fly across the U. S. in less than 24 hours; he was the first to fly over 300 *mph* in a landplane; he was the first to do the hazardous outside loop; and he pioneered the science of blind flying by taking off, flying a set course and landing without seeing the ground.

His military service commenced in World War I when he enlisted as a flying cadet in the aviation section of the U. S. Signal Corps. He remained on active duty as an aviator and aeronautical engineering officer until 1930 when he became aviation manager of Shell Oil. He was recalled to active duty with the U. S. Air Corps in 1940. His first assignment was to help in the conversion of the automotive industry to the manufacture of aircraft and component parts.

He led the famous Tokyo raid in April, 1942, for which he received the Congressional Medal of Honor. Later he commanded the 12th and 15th Air Forces and, in January, 1944, took command of the 8th Air Force, the world's largest and most powerful strategic-bombing force. In January 1946 he resigned as a Lieutenant General to rejoin Shell as vice-president and director.

Doolittle was born at Alameda, Calif., received his higher education at the University of California, and later won his Master of Science and Doctor of Science degrees in Aeronautical Engineering at the Massachusetts Institute of Technology.

He is a past president and a fellow of the Institute of the Aeronautical Sciences, a fellow of the Royal Aeronautical Society, chairman of the board and past president of the Air Force Association and a member of the National Advisory Committee for Aeronautics.

Third, to help maintain British prestige and her position in world commerce, the British Government has subsidized her aircraft manufacturers heavily to enable them to develop and produce new planes to be used on her nationalized airlines. She hopes that these new planes will be good enough to permit her to sell them in other countries, including America, and thus substantially improve her position in the world's aircraft market. Subsidies on the *Viscount*, I am advised, have amounted to approximately 20 million dollars and, although de Havilland courageously took considerable risk in the construction of the *Comet*, it is reported that the development cost was financed partially by the British Ministry of Supply to the extent of about 17 million dollars.

★ ★ ★

While we are behind the British in the development of commercial jets, we are not behind them in the development of all jet aircraft. In this connection, I would like to

(Continued on page 92)

AVIATION EARNINGS

Cessna Aircraft Co. reports aircraft sales of $6,560,370 for the fiscal year ended Sept. 30, 1949. Net earnings amounted to $299,936.

Mid-Continent Airlines showed a net profit of $20,726 for November 1949, compared with a net loss of $11,937 for November 1948 A dividend of 25c per share was declared.

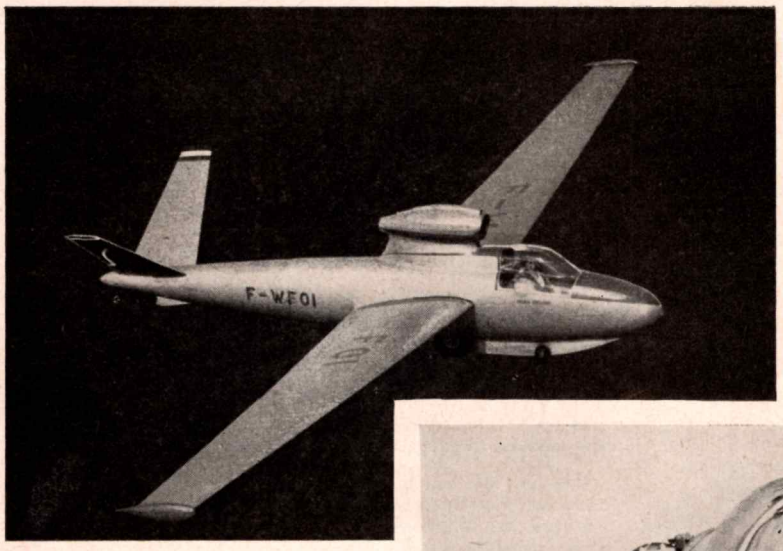
Pan American World Airways, Inc. has declared a dividend of 25c per common share.

Pioneer Air Lines announces a dividend of 25c per share on its outstanding common stock.

Ryan Aeronautical Co. reports sales totaling $15,268,087 for 1949. Net profit after taxes was $346,674, aproximately the same as in 1948.

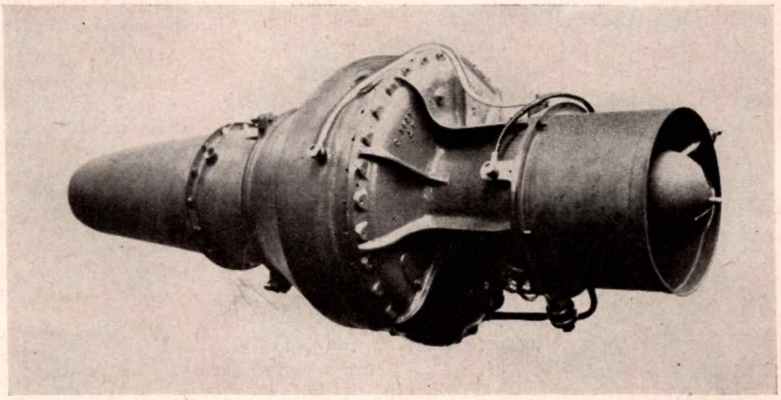
Texas Engineering & Manufacturing Co., Inc. has declared the regular quarterly dividend of 10c a share, common, bringing the total dividend for 1949 to 40c

The Air Transport Assn. of America states that the 16 domestic trunk airlines showed a total net operating income of $24,342,851 for the first nine months of 1949. This compared with a loss for the nine months period of 1948 of $8,214,062.



JET-POWERED SPORT PLANE

PAUL H. WILKINSON
Powerplants Editor



Turbomeca "Pimene," the first gas turbine to power a piloted lightplane in flight; of simple, centrifugal-type construction with annular combustion chamber. Weighs 120 lbs, rated at 220 lbs thrust at 35,000 rpm. It powers the vee-tailed Fouga "Cyclone," substantially a mid-wing glider; is mounted atop the fuselage behind the cockpit

THE American public had its first preview of things to come in the lightplane field recently when a miniature jet-powered glider virtually stole the show at the All-American Air Maneuvers at Miami. Billed on the daily program close after the aerobatics displays of the full-size jet fighters of the military services, the little privately-owned jet put on such an impressive performance that many an onlooker wished that he or she could own one.

It came as a distinct surprise to many of the flying enthusiasts present to find that the larger jet planes could be scaled down for private use. Yet there was the proof, on the ground and in the air for all to see!

This miniature propellerless craft, which made aviation history as the first jet-propelled piloted light airplane to fly in America, is of French origin. Known as the Fouga *Cyclone*, model C.M. 8-R13, this prototype is a product of the well-known firm of Fouga & Cie., of Landes, specialists in gliders and sailplanes. The jet engine powering it is the Turbomeca *Pimene*, model TR-011, named after some small peak in the Pyrenees Mountains and built by the Societe Turbomeca at Bordes in the Department of Basses-Pyrenees, to the designs of M. Szydlowski, president of this old-established firm which specializes in turbo-superchargers and gas turbines.

The French team, which came over and demonstrated the Fouga *Cyclone* so effectively, comprised Marcel Doret, manager, Fred Nicole, pilot, and Jules Baudet, mechanic. Augmenting them and available for information about the plane's powerplant, was Joseph Szydlowski, designer of the little turbojet which made the demonstration possible.

Each day during the Air Maneuvers the little *Cyclone* was rolled out from the hangar, the pilot got in and adjusted the controls, the starter and battery cart were plugged in, the engine spun up to speed, and fired, and then speeded up on its own, accompanied by a miniature version of the high-pitched whine of the larger turbojets. The plane was airborne after a run of about 1200 *ft*, climbing smoothly and easily at about 800 *fpm*. The pilot put it through various maneuvers at its top speed of about 160 *mph*, and then slowed it down with its air brakes and floated by at about 30 *mph*, a few *feet* above the ground.

According to the French team demonstrating it, the *Cyclone* could have remained in powered flight for nearly 1.5 *hr* before the 26 *gals* of kerosene in its tanks had been used up, covering approximately 185 miles in still air at an altitude of 13,000 *ft*. Its service ceiling is said to be 28,000 *ft*, which is within the capabilities of its jet engine, despite its diminutive size.

The *Cyclone* is a conventional mid-wing glider with its powerplant mounted on top of the fuselage behind the pilot. It has a vee-type tail, à la *Bonanza*, to eliminate aerodynamic disturbances which might be caused by the high-velocity exhaust gases from the engine. The fuselage is of monocoque construction, with the pilot's cockpit and its detachable *Plexiglas* enclosure well out in the nose where excellent visibility is obtained.

The wing is of twin-spar cantilever construction, with an aspect ratio of 13:1. Landing flaps occupy approximately one-half of the trailing edge, and there are also retractable dive brakes which can be rotated to form

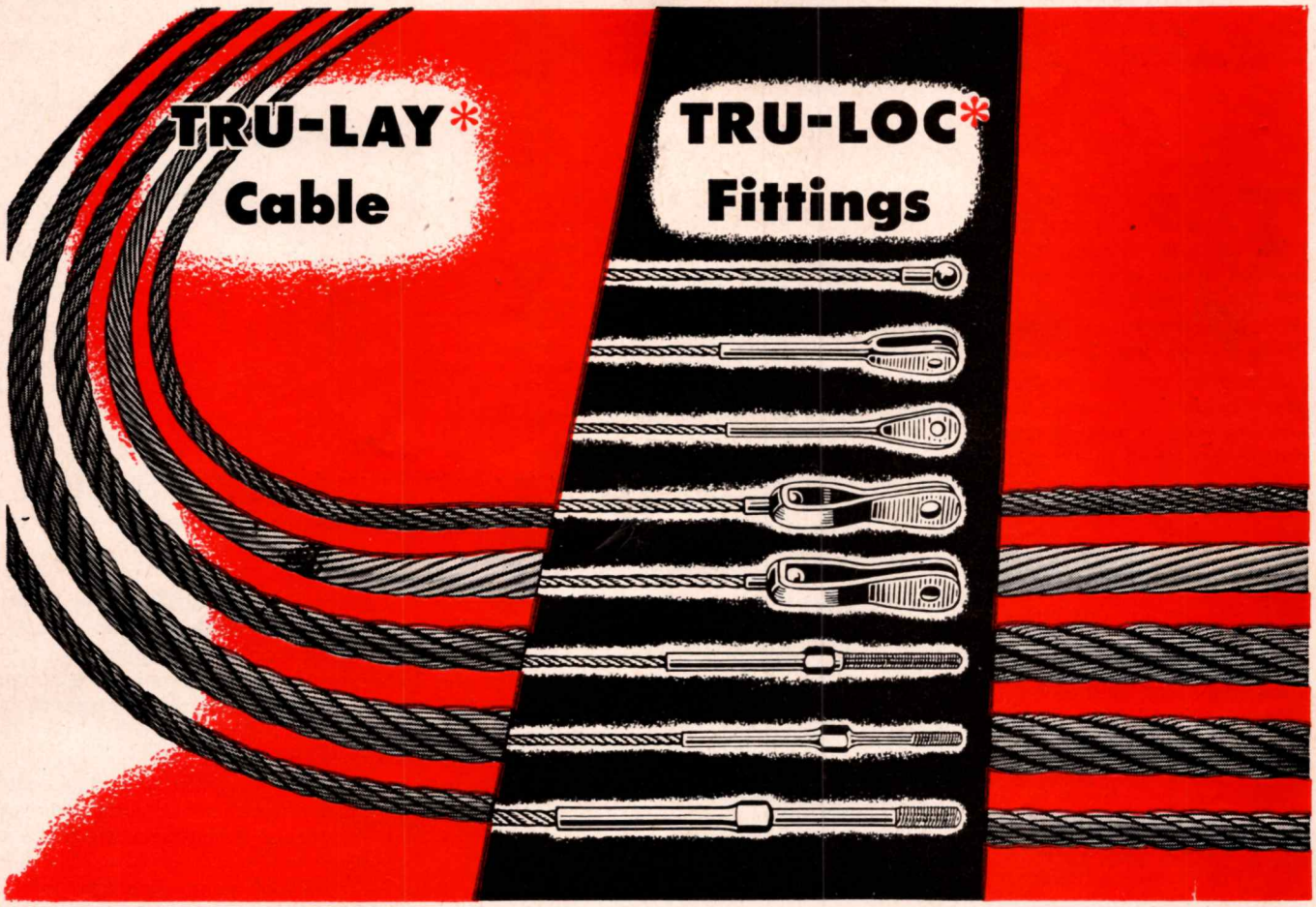
(Continued on page 104)

Table 1

	Takeoff power	Weight *(lbs)*	Specific weight *(lbs)*	Specific fuel cons. *(lbs)*	Frontal area *(sq ft)*
Turbomeca "Pimene" ..	220	*130	0.59	1.06	1.4
Continental E-185	185	350	1.88	0.48	3.4
Franklin O-425-5	245	405	1.65	0.51	3.5
Lycoming O-435-C2 ..	260	460	1.77	0.47	6.8

*with starter

Reliable—as always



NAMES are important in Aircraft. Names are important in controls,* too. We have specialized in making cable, fittings, swaged assemblies and TRU-LAY Push-Pull Controls to aircraft specifications. From long experience, we know the problems of rotary swaging—and how to solve them. Moreover, having worked closely with the aircraft industry almost since it began, we realize the vital importance of dependable controls.

For information about aircraft cable, fittings, assemblies or Push-Pull, write our Detroit office.

ACCO

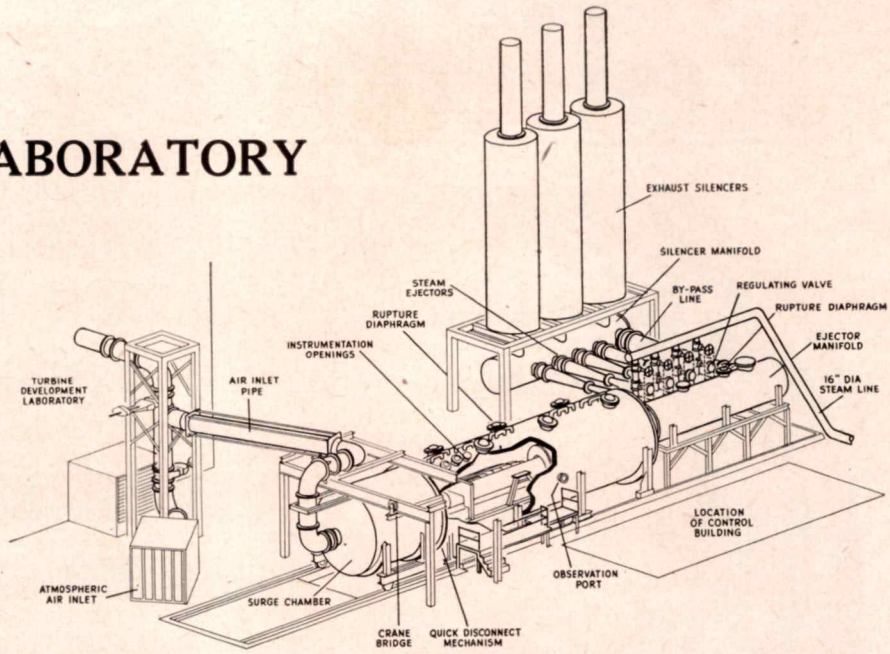
6-235 General Motors Bldg., Detroit 2 • 1119 Santa Fe Ave., Los Angeles 21 • Bridgeport, Conn.

AUTOMOTIVE AND AIRCRAFT DIVISION
AMERICAN CHAIN & CABLE

TRADE MARK

In Business for Your Safety

RAMJET LABORATORY



Wright Aeronautical unit tests combustion chambers under controlled conditions. Air for test chamber is supplied by turbine compressors in the adjacent Gas Turbine Development Laboratory. Steam ejectors control exhaust gases

THE importance of the practical propulsion possibilities of the ram-jet engine is again highlighted by the announcement of a new laboratory built and operated by the Wright Aeronautical Corp. at Wood-Ridge, N. J. Ramjets up to 20 inches in diameter can be operated inside the test chamber. Planned modifications are expected to make it possible to test future units of twice that size.

Designed and constructed under an Air Force contract, the ramjet laboratory adds still another research unit to Wright Aeronautical's multi-million dollar facilities for the testing of turbojets, turboprops and ramjets.

The laboratory can simulate flight speeds up to 2600 *mph*, roughly four times the speed of sound. In addition to extremely high speed, it is possible to simulate altitude conditions of 80,000 *ft*, or more than 15 miles.

Designed principally for guided missiles and pilotless aircraft, the ramjet is essentially a simplified "expendable" engine which has been developed to a considerable degree in the U. S. since the end of the war. The ramjet is most effective at speeds in the supersonic realm.

Although data concerning the output of the engine to be tested by Wright Aeronautical are restricted information, the capacities of the laboratory give an indication of the tre-mendous bursts of power attainable from this type of powerplant. For instance, the fuel pumps supplying the engine on test are capable of delivering more than 6000 *gals* per hour. Steam at the rate of 150 tons per hour is fed to the exhaust system to aid the escape of the hot gases from the rear of the ramjet. A special steam-producing unit had to be built to furnish this enormous quantity.

Air for the test chamber—at the rate of 140 tons per hour—is supplied from turbine compressors on test at the nearby Gas Turbine Development Laboratory, itself a $3,500,000 structure erected two years ago under Air Force sponsorship.

Absorbing the Heat

An elaborate cooling system, which jackets the chamber with a layer of circulating water, was built as an integral part of the tank to absorb some of the great heat created by ramjet combustion. At certain parts of the chamber, notably near the exhaust end, the temperature of the gases reaches 4000°*F*. This heat causes the test chamber to expand about one inch over its entire length and it is consequently supported by rollers.

To muffle the roaring of exhaust gases and steam jets, three silencers, each 45 *ft* in height, have been installed at the end of the exhaust line.

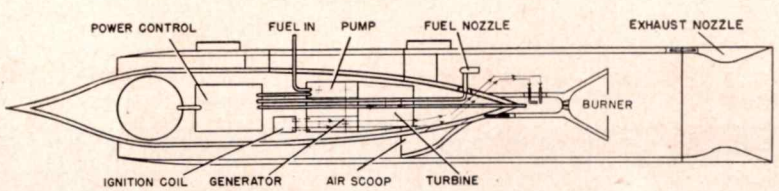
The central test cell of the laboratory is a steel tank 12 *ft* in diameter and 96 *ft* long. Air is pumped to this chamber from the development laboratory, passing through a surge chamber which reduces turbulence on the way. The ramjet to be tested is mounted on a platform in the center of the test chamber and connected with an electronic thrust-measuring instrument.

A series of steam jets are pointed into the exhaust system to aid or retard the escape of exhaust gas, and, by varying the incoming air pressure and the outlet pressure, it is possible to "starve" or "overfeed" the engine and thus create within it the simulated effect of altitude or speed.

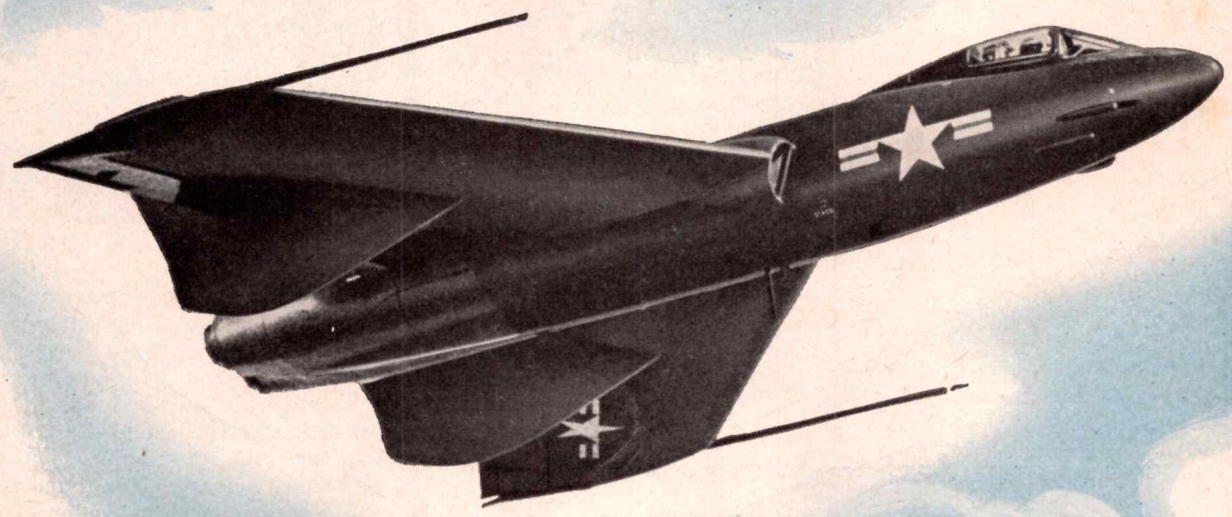
The laboratory is basically a test facility for ramjet combustion chambers. However, this type of powerplant needs few additional elements once the critical problems of air-fuel supply, mixture, control and ignition within the combustion chamber have been solved.

The steel, tank-type test cell may be separated into two parts, at a bolted-flange connection, for the insertion and removal of ramjet units undergoing test. The movable section is mounted on rollers and tracks to simplify this operation.

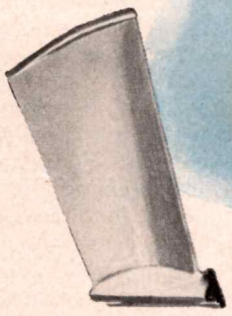
Wright Aeronautical's test programs also have been caught in the economy directives sent forth by the Department of Defense. Construction of the new laboratory was accomplished by an ingenious use of materials and processes readily available, at a relatively moderate cost.

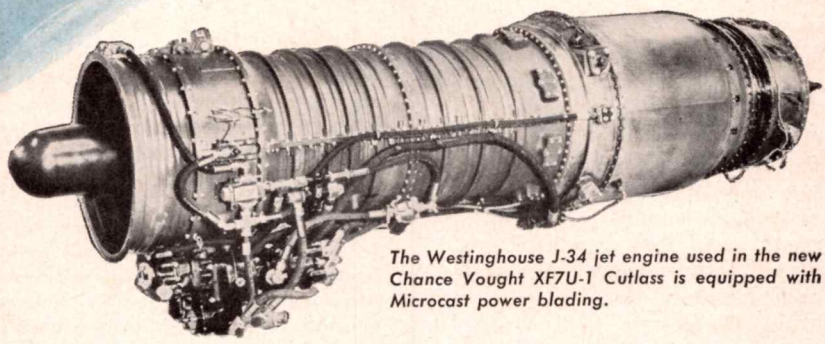


Typical ramjet of a type being investigated. Although appearing to be ridiculously simple, this type of powerplant presents knotty problems in the introduction and proper combination of air and fuel. Allowances must be made for less than optimum conditions



MICROCASTINGS...Basic Components in Jet Turbines





The Westinghouse J-34 jet engine used in the new Chance Vought XF7U-1 Cutlass is equipped with Microcast power blading.

The Microcast Process has proven ideal for the specialized production requirements of power blading for jet turbine, gas turbine, and the other revolutionary new types of aircraft power development units.

During the war years, Microcast was selected as the production process for millions of turbo-supercharger blades. These blades as well as the blades used today in aircraft turbine units must withstand extreme thermal and dynamic stresses. They require the use of the high melting point, non-machineable and non-forgeable alloys. The answer to economical quantity production of these blades is Microcast, for Microcastings as cast are sound, smooth, and dimensionally uniform. They require virtually no machining.

Perhaps Austenal's experience can help you, too.

WRITE FOR BOOKLET. More complete information on Microcast is contained in a new 16-page booklet published by Austenal Laboratories, Inc., originators of the Microcast Process. This valuable booklet is fully illustrated and describes many applications for Microcasting as well as a step-by-step description of the process itself. Write for your copy today.

The name MICROCAST is a registered trademark of Austenal Laboratories, Inc.

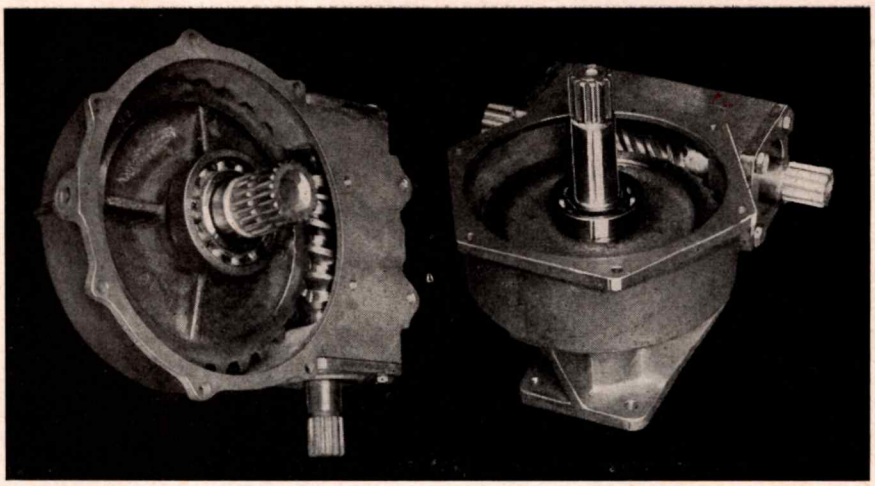
MICROCAST DIVISION
AUSTENAL LABORATORIES, INC.
224 East 39th Street • New York 16, New York
715 East 69th Place • Chicago 37, Illinois

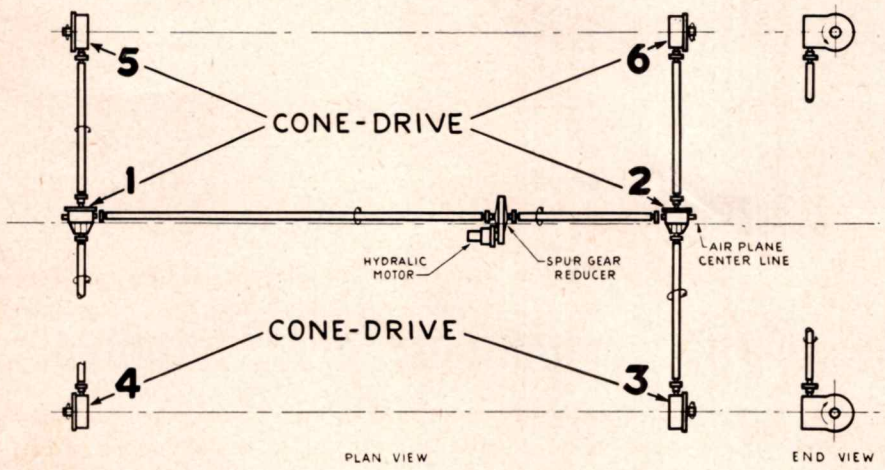
MICROCAST PRECISION CASTINGS PROCESS

MICROCAST

COPYRIGHT 1949, AUSTENAL LABORATORIES, INC.

GEARED ACTUATORS FOR "NEPTUNE"





COMPACT and remarkably light in weight, a new-type bomb-bay door actuator system is currently in use on all Lockheed P2V-4 *Neptune* patrol planes. Remarkable standardization of parts has been achieved in the unit which comprises six cone-drive geared actuators connected by torque tubes, a spur-gear reducer and a hydraulic motor.

According to Western Gear Works of Lynwood, Calif., designers and manufacturers of the complete unit, this radically different bomb-bay door actuator provides:

1. *Lighter Weight.*—The entire assembly weighs only 109 *lbs* complete. A saving of 50 *lbs* is attributed to the use of "double enveloping" Cone-Drive gearing because of the decreased size of both housing and gears made possible by the high load carrying capacity of the gears. Cast aluminum is used for the housing to further decrease weight
2. *Standardization.* — Providing maximum interchangeability of cone-drive gears and housings with a minimum of parts required, manufacturing costs have been reduced and maintenance in the field has been greatly simplified
3. *Extremely Long Life.*—Attributed to the fact that the gears are produced by a special gear-cutting process, giving them area contact rather than point or line contact as is the case with conventional-type gearing
4. *High Torque Capacity.*—More teeth in contact and more contact area per tooth enables the outer actuator to deliver 9000 *in-lbs* torque to the bomb-bay door arms with a center distance of only 4 *in.* The two inner actuators, which also utilize cone-drive gearing, will withstand a maximum torque load of 1400 *in-lbs* despite a center distance of only 3 *in*
5. *Remarkable Compactness.*—Due to the small center distances possible, less space is required
6. *Greater Efficiency.* — Furnishing an over-all reduction ratio of 75:1, the gears are said to have an inherently higher efficiency than worm gears of equal capacity.

The accompanying diagram shows a schematic layout of the actuator unit installed in the *Neptune.* Power from the 8-*hp*, 3750-*rpm* hydraulic motor is transmitted by torque tubes to both forward and after ends of the setup with an initial 6.4:1 ratio spur-gear reduction. Actuators Nos. 1 and 2 furnish a further speed reduction of 5:1, driving transverse torque tubes at right angles to the plane centerline. This actuator is provided with a double-ended pinion shaft, so that the same cone-drive gear assembly, manufactured by Michigan Tool Co., may be installed at each end of the center driveshaft.

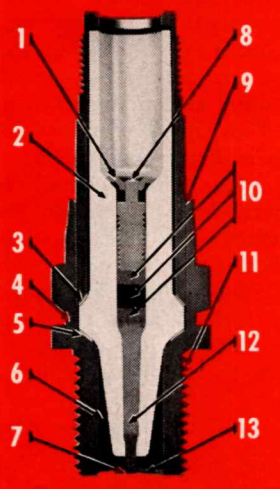
Actuators Nos. 3, 4, 5 and 6, are all similar, having a 15:1 ratio. Right- or left-hand assembly is readily attained simply by reversing the position of the pinion in the housing and by changing to a gear with shaft extended on the opposite side. Actually, only a single-type housing, two types of pinions (right- and left-hand thread) and two types of gears having shafts extended on either side are needed for all four corner actuators.

In the P2V installation, the four corner actuators operate the bomb-bay doors through arms attached to the output shafts. A locking mechanism is provided to secure the door in either the open or closed position. Bombs, torpedoes or depth charges are held in racks above the actuator system and are dropped through the openings on either side of the hydraulic motor and center driveshaft.

"The British now are firmly committed to a course of action of specific jet-transport types. We believe we can take advantage of that fact if immediate action is taken to establish a program in this country which will provide the financial backing required to initiate prototype development and production. In other words, we can pick up where they have left off and bring out an improved airplane."

—WELLWOOD E. BEALL
Boeing Airplane Co.

"If time is money Here's a Bargain!"



1 Core contact cap
2 One-piece insulator:
1. Patented Coralox. 2. No flashover downward from contact cap. 3. Eliminates dirt trap between core insulator and shielding barrel insulator. 4. Facilitates cleaning terminal well. 5. Mechanically rugged.
3 Nickel gasket
4 Heat-sealed, leakproof assembly
5 Nickel gasket
6 Ample clearance for abrasive blast cleaning
7 Platinum center electrode tip .060" dia.
8 Steel core pin
9 Brazed one-piece construction with zinc-plated finish
10 Gastight Hermetic seal
Copper-glass conducting seal. Glass-graphite resistor seal, halving electrode wear. Copper-glass conducting seal.
11 18 MM threads, precision-rolled to mirror finish
12 Silver, centrifugally cast to insure good heat conducting contact with insulator
13 One of two large .040" square platinum ground electrodes

The AC-181 Aircraft Spark Plug resists lead fouling better than any other plug ever built. Off-schedule changes are fewer than with any other plug we know of. Two reasons are the platinum electrodes, which assure longer fixed gaps, and the patented *CORALOX* one-piece Insulator.

Consequently, the AC-181 is a bargain, because its longer life and freedom from trouble make it truly economical, when *all* cost factors are considered.

Take a look at the sectional drawing and you'll see why Pratt & Whitney and the CAA have approved the AC-181 for five P & W engines, and why "Lucky Lady" used it in her sensational round-the-world flight.

There's no other aircraft plug like it—none that can offer you its combination of extra-quality features.

AC Plugs for Jet engines have also participated in the establishment of many speed records

AC SPARK PLUGS
AIRCRAFT

AC SPARK PLUG DIVISION • GENERAL MOTORS CORPORATION • FLINT 2, MICHIGAN

THE BUDGET GASPS FOR AIR

With the best intentions in the world, the current Economy Congress may strangle the child unless all good men and true stand by for action

KENDALL K. HOYT
Washington Editor

ANOTHER year of profits for aircraft, electronics and civil air suppliers is assured from the Budget for fiscal 1951, even if somewhat cut by the economy Congress. Any large additions, as voted in prior years, can't be counted on unless there is a change in the foreign outlook.

In this mid-term election year, economy is urged from home more strongly than ever. Hoover Commission plans for saving billions are popular. As they are supplied by both Congress and the Executive, aviation interests may well keep watch in both directions.

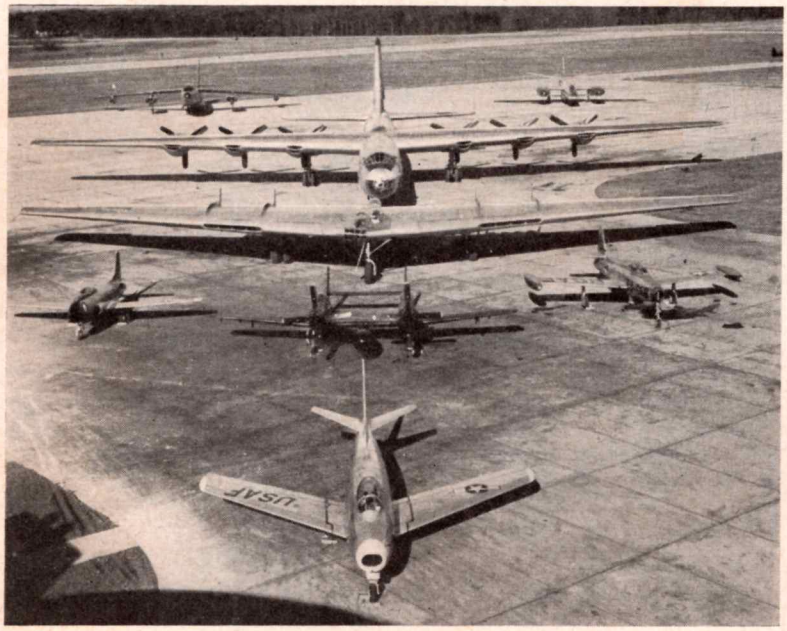
The Battle of the Budget is more a holding action than an advance this year. In 1948, Congress overrode the administration in a big air-power boost. In 1949, the House did it again; but the Senate let the money be voted only with the expectation that the increase would be impounded by the Department of Defense—as it was.

In 1950, there is no assurance—as this is written—that either House will insist on more appropriations than the officials ask. On the other hand, across-the-board slashes may fall upon air items just as on the rest of the budget.

Rather than raise taxes to support big spending for all manner of social purposes, as Truman demands, Congress wants to cut spending. Also, relief from wartime excise taxes, although helpful to the airlines, may occasion a drive for saving the amount of revenue to be lost.

The one-package appropriation idea further weighs toward economy. Under the old plan of splitting appropriations into several departmental bills, each considered without reference to the other, the popular ones got special treatment. When they are all lumped together, Congress can apply a ceiling and can put the squeeze on the whole Federal establishment to stay under it.

The Air Force is not competing for funds merely with the Army and Navy, as in the military supply bills of prior years, but in relation to the whole budget. The truth is that air power still has absolute needs without relation to anything but its security role. But the farther away from the lessons of the last war, the harder it is to resell what the nation once learned.



On the USAF ramp at Andrews AF Base, Md.; Shown are the North American F-86 "Sabre," Lockheed F-80 "Shooting Star," North American F-82 "Twin Mustang" (night fighter), Republic F-84 "Thunderjet," Northrop B-49 "Flying Wing," Consolidated Vultee B-36, Boeing B-47 "Stratojet," and North American B-45 "Tornado." The Boeing B-29 and B-50 "Superfortresses," additional USAF "front liners," are not shown

Air Power First

Air power, at least, is emerging in first place over the older weapons. The military totals for recommended appropriations in the 1951 budget are $4.0 billion for Army, same for Navy, and $4.6 billion for the Air Force. Totals for the 1950 fiscal year are $4.4 billion Army, $4.3 billion Navy, and $4.1 billion Air Force.

The Air Force increase, however, is to pay for contract obligations made in prior years, while most other parts of the air budget were cut a little and are still subject to more whittling in Congress unless a very firm hands-off policy can be established.

According to the Budget message, $2.1 billion will be spent in the 1951 fiscal year for approximately 2300 airplanes, compared with $1.7 billion for approximately 2800 airplanes in fiscal 1950. The change in unit cost, it is stated, reflects "the increasing complexity and cost of individual airplanes." *(Continued on page 68)*

Pilots demand it!
Instruments deserve it!
Safety requires it!

Engine Control Equipment
Air Pumps
Engine Starting Equipment
Hydraulic Equipment
Ice Elimination Equipment
Power Supply Generating Equipment
Power Supply Regulating Equipment

★

Flight Instruments
Automatic Pilots
Flight Path Control Systems
Engine Instruments
Navigation Instruments

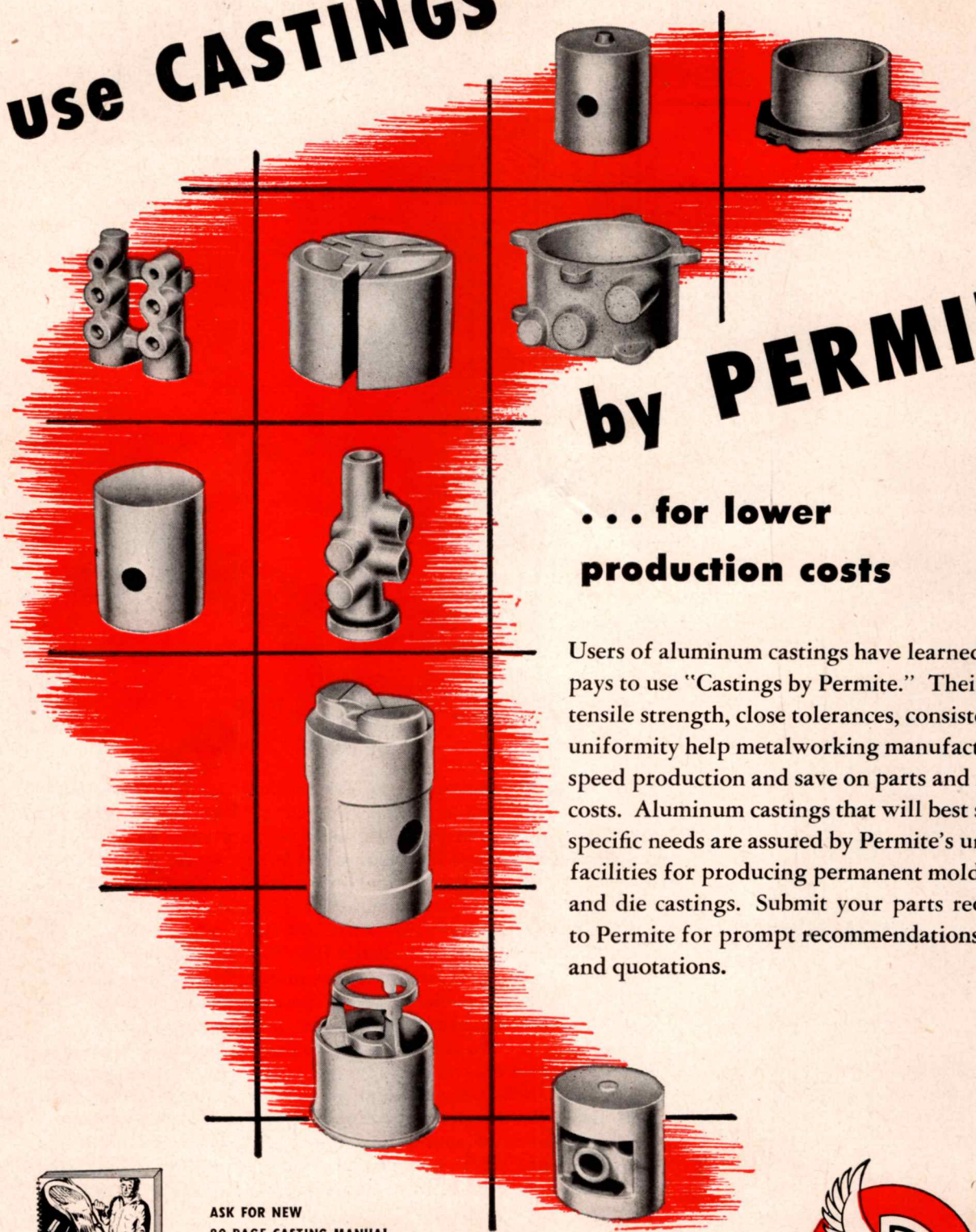
Pilots today are demanding an independent standby power package to insure operation of their electric flight instrument group. For they know that even the finest instruments money can buy, are reduced to dangerous liabilities when faulty power renders them useless or causes them to give incorrect indications. Eclipse-Pioneer's answer is a two-component package consisting of a lightweight ENGINE DRIVEN ALTERNATOR, and a small, panel-mounted POWER FAILURE INDICATOR. Normally, the small black face of the indicator is inconspicuous in its mounting near the gyro horizon, but if conventional power becomes faulty, a fluorescent disk instantly appears—giving the pilot approximately four minutes to switch to standby power before the gyros will precess. Two alternators are available for this system; one for electric gyro flight instruments only and the other for an electric compass as well as the flight instruments. Either one is conveniently installed on the engine vacuum pump drive pad. Here is instrument insurance that pays its own premiums—another example of the developments that have made Eclipse-Pioneer the leader in its field.

ECLIPSE-PIONEER DIVISION OF
TETERBORO, NEW JERSEY

Bendix
AVIATION CORPORATION

Export Sales: Bendix International Division, 72 Fifth Avenue, New York 11, New York

use CASTINGS by PERMITE



. . . for lower production costs

Users of aluminum castings have learned it pays to use "Castings by Permite." Their greater tensile strength, close tolerances, consistent uniformity help metalworking manufacturers speed production and save on parts and labor costs. Aluminum castings that will best serve your specific needs are assured by Permite's unexcelled facilities for producing permanent mold, sand and die castings. Submit your parts requirements to Permite for prompt recommendations and quotations.

ASK FOR NEW
80-PAGE CASTING MANUAL

Authoritative illustrated manual on the design, production and uses of aluminum castings. Includes casting alloys tables. Sent free on request to interested executives.

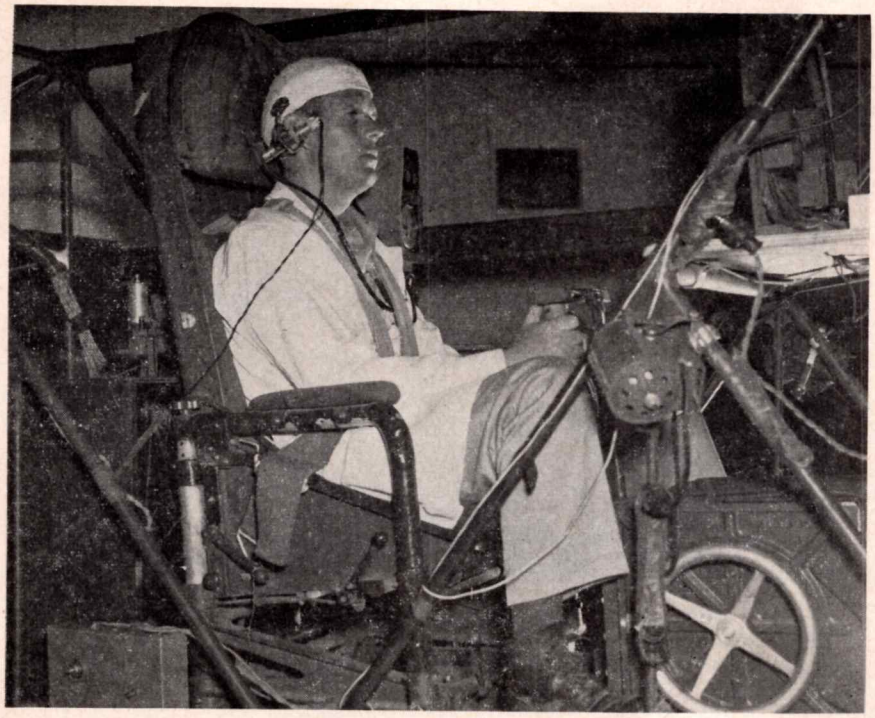
PERMITE

ALUMINUM INDUSTRIES, INC.

CINCINNATI 25, OHIO

DETROIT: 809 New Center Building. NEW YORK: 9 Rockefeller Plaza. CHICAGO: 64 E. Jackson Boulevard. ATLANTA: 413 Grant Building

ALUMINUM PERMANENT MOLD, SAND and DIE CASTINGS...HARDENED, GROUND and FORGED STEEL PARTS



Air Materiel Command photo

In the human centrifuge for a test blackout run. Translating human reaction into something which will alter course, speed, or some other prime control function usually involves an additional time lag—the reaction time of airfoils or other components necessary to produce desired effects. Devices which can make valid decisions are indicated

Cybernetics and Aviation Medicine*

Paul A. Campbell, M.D.

A VERY scientifically minded individual should on occasion be allowed to journey beyond the horizon of the conventional. Such a journey may offer a glimpse of things to come at a time when his own thinking and possibly that of others has become entwined by the conventional and possibly has bogged down. The science of Cybernetics,[1] as set forth by Norbert Wiener's recent monograph on the subject, offers just such a respite. Cybernetics, according to its champions, includes the study of human control functions and mechanico-electrical systems designed to replace them.

One does not have to delve very deeply into the connotations of the subject to find many important correlations and applications which are of interest to the science of aviation medicine. We all well know that instruments and mechanisms to supplement or take the place of human control appeared almost with the advent of aviation. They appeared and were adopted for the simple reason that they could perform tasks or furnish information more precisely, more efficiently or more quickly than could the human organism.

Among the earlier of these mechanisms was the automatic thermo-regulator mechanism for control of engine temperature. By means of this simple mechanical device the pilot was relieved of the necessity of constantly adjusting ventilators, coolant flow, etc., to keep his engine at an optimal operating level.

Not long after instrument flight had become a fact, the orientation instruments were coupled through servo-mechanisms with the controls of aircraft, making automatic pilotage possible. Once again the pilot was relieved of many duties which could be performed more or less automatically. This control device was not subject to false perceptual stimuli from the vestibular apparatus or conditioned by such psychogenic stimuli as anxiety. Fatigue did not influence its performance. We may say that it was born at maximal efficiency and did not need years of experience for the development of its abilities.

Advances in electronic computing mechanisms recently have made possible the solution of complex mathematical problems hundreds and possibly thousands of times more rapidly than could be accomplished by the mathematician. Tracking and predicting mechanisms, automatically computing sighting and firing data, have increased the accuracy of fire many times in modern weapons. Devices which simulate memory now can be built into computing and predicting mechanisms in a manner in which past experience can be called into the solution of problems. Some of the newer devices can make valid decisions which may be of complex nature. The principles utilized in these devices well may be applied to the controls of aircraft when the human is no longer capable or able to cope with the newer problems.

As has recently been pointed out by Willy Ley in his book *Rockets and Space Travel*[2] experimental study has reached the stage of development at which it appears plausible that, in the not-too-distant future, it will be possible to build self-propelled carriers able to travel in space far above our atmosphere. It is plausible also that these self-propelled carriers will be able to reach speeds enabling them to break away from terrestrial gravitational influence and thus become satellite carriers operating in the so-called "hard vacuum" of space. What now are the primary physiological and psychological limitations to such travel which must or may be overcome by electronic, chemical and/or mechanical devices? The primary limitations are oxygen lack, high degrees of barometric-pressure change, high degrees of temperature change, acceleration and deceleration, cosmic and ultraviolet irradiation and, probably the most serious limitation of all, inability of the human organism to cope with the speeds involved.[3] These limitations have plagued aviation medical scientists for a long time, but never in such degree.

Considering each of the limitations in order, one can find, in texts of electronics, physics and engineering, sufficient evidence to support the thesis that none of these limitations is insurmountable as far as mechanical and electronic control devices may be concerned.

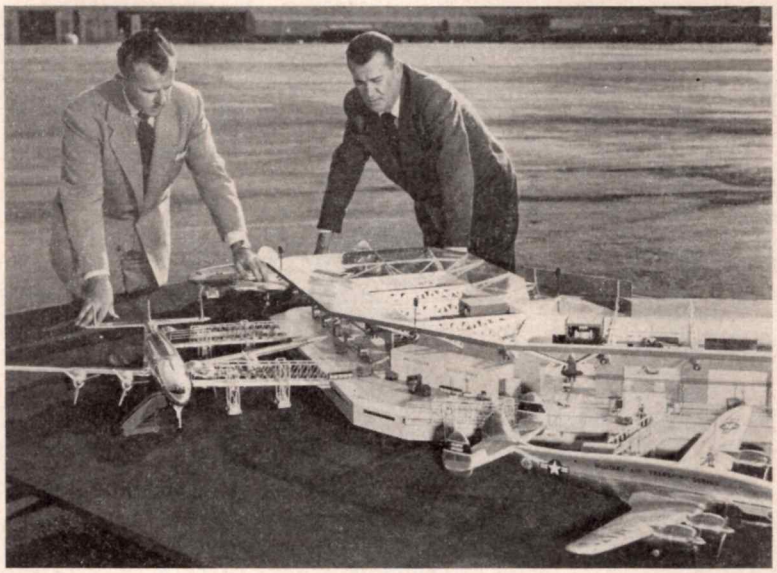
Oxygen lack has little influence on most of the types of electronic- or mechanical-control device which might be applicable. If oxygen is consumed at all in such devices, it is negligible

(Continued on page 74)

* This paper was presented at the Aero Medical Association's annual meeting in New York, 1949.

AIR CARGO 1950

GERARD E. NISTAL



Lockheed has long been interested in air cargo. Here L. R. Hackney and Gordon Stanton inspect a Lockheed-designed model cargo terminal to facilitate ground handling

DURING the past five years, air-cargo transportation has become an industry so large and vigorous that it is said to have opened an entirely new vista in the field of aviation. New aircraft are being designed specifically as long-range and feeder cargo transports; cargo terminals are being planned and constructed; operations and traffic procedures are being revised radically. These and many other changes are tending wholly to revise our thinking, not only in aviation, but in domestic and foreign industry and commerce as well.

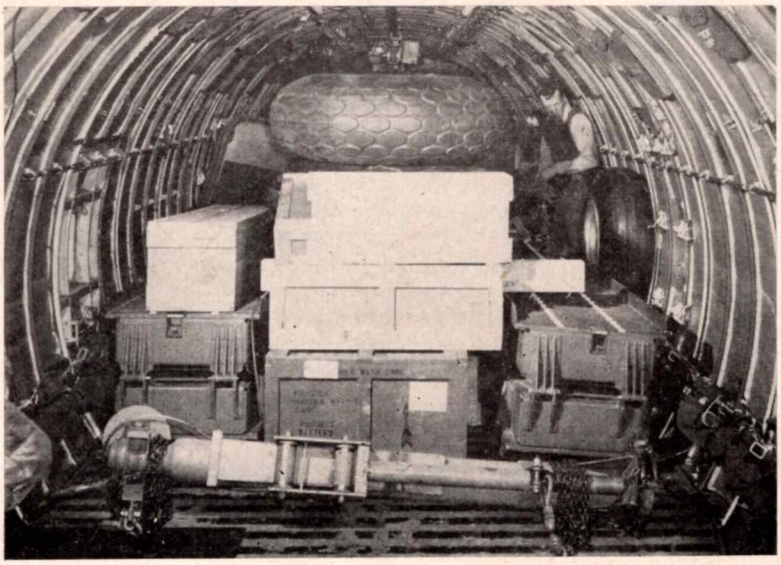
For all practical purposes, credit for the introduction of scheduled air cargo in this country can be given to the old U. S. Army Air Corps, or, more specifically, the General Headquarters Air Force, commanded in 1937 by Maj. Gen. Frank Andrews. The Air Corps at that time operated several supply depots in various parts of the country, including San Antonio, Tex.; Middletown, Pa.; Dayton, Ohio; and Sacramento, Calif. Each of these major depots had under its control several sub-depots in its geographic area. Spare parts, equipment and accessories were shipped from the manufacturer to whichever major air depot had requisitioned them. It was the depot's responsibility then to distribute these supplies to its sub-depots and operational units needing them. This was done, for the most part, by rail and truck, with a few instances of units being shipped critically needed emergency supplies in the depots, few C-33 or C-39 aircraft.

One of the first moves of the new GHQ Air Force was the organization of the 1st Transport Group, U. S. Army Air Corps, with one area headquarters at San Antonio Air Depot, another at Sacramento Air Depot and a third at Dayton Air Depot. Douglas C-33 and C-39 aircraft and smaller feeder transports were assigned to the Group, and a scheduled cargo- and personnel-transport service was inaugurated between major air depots, their sub-depots and major operational air bases.

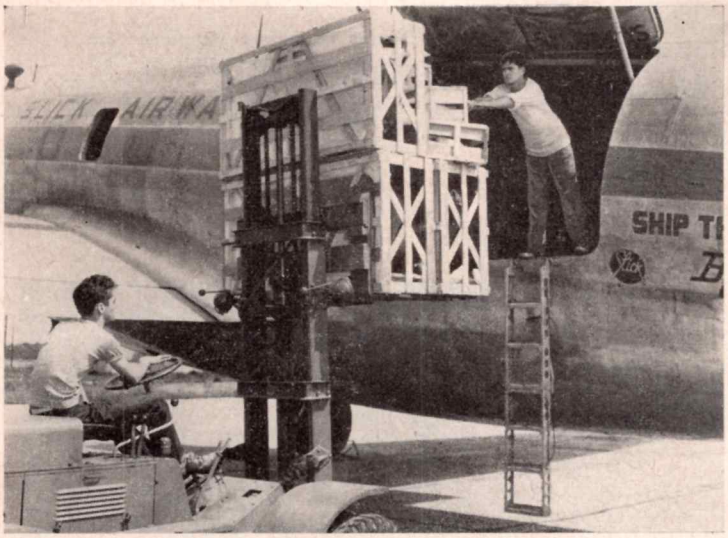
This expanded over the years into the Air Transport Command until, in 1940, it was operating weekly flights to France and Albrook Fields in the Panama Canal Zone. In the first six months of that year, ATC flew almost two million miles, carrying over four million *lbs* of military cargo, using Douglas C-39, C-49 and C-53 aircraft. A year later, the Ferrying Command inaugurated a scheduled transport service between New York and England, to carry officials and light cargo directly to that country, since the Neutrality Act prohibited American or British civilian carriers from operating this route.

One month later, in August 1941, Pan-American World Airways pioneered a ferrying and cargo route to the Middle East via West Africa, using ATC aircraft. During this same month, the Army Air Forces announced that their 50th Transport Wing was carrying more cargo than all the commercial airlines combined, including 40% of all LCL cargo moving on Government bills of lading.

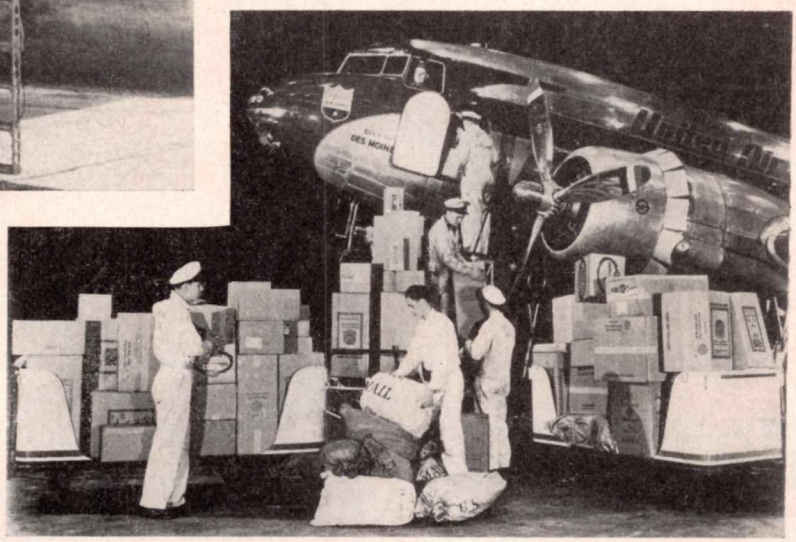
Shortly thereafter, the Ferrying Command was absorbed by ATC and became one of its eight divisions: Domestic, Atlantic, Pacific, European, African, Caribbean and China-Burma-India. Domestically, all cargo traffic originally was handled by Air Service Command's 39th Air Freight Wing, which took control of the cargo from the moment it left the manufacturer or the supply depot until the ATC pilot signed for his load just before takeoff, and from the moment an incoming



Military cargo for "Project Vittles." Both the Air Force and the Navy use mostly passenger-type planes for freight. This is a Boeing C-97 "Stratofreighter"



Left: Bulky cargo requires lift-truck equipment at both ends of the flight to transfer shipments in and out of planes whose doors are high above the ground. Like this Slick C-46, freighters in common service require high lifting. Below: A familiar sight just a short time ago—chain-handling of variously shaped packages for stowage into the cramped quarters of a United Airlines DC-3. Although the present four-engined passenger-mail-express transports have more room, shipments must be stuffed into inconvenient compartments



plane landed until the cargo reached its ultimate domestic consignee. But, in March 1944, the 39th Air Freight Wing was absorbed into Air Transport Command as its ninth division.

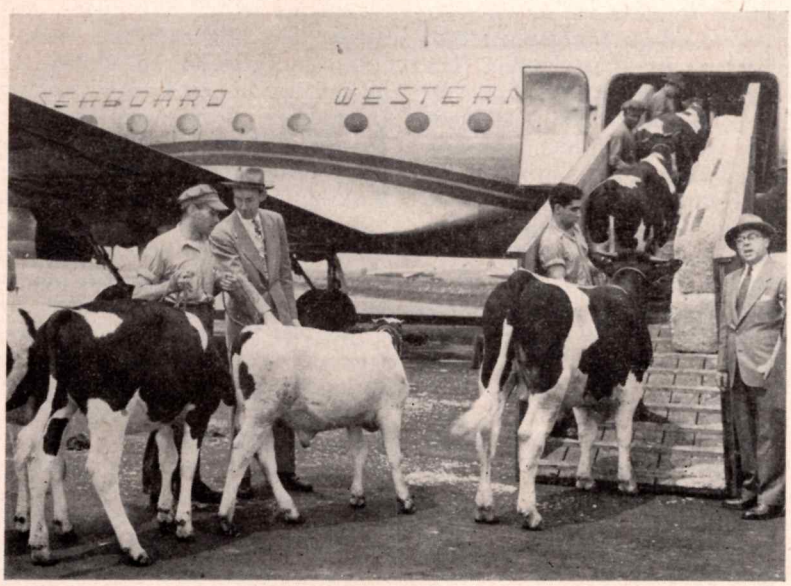
In the meanwhile, the Navy was not napping. In January 1942, the Naval Air Transport Service was organized, utilizing Douglas R4D's, Martin PBM-3R's and a few PB2Y-3R's and R5D's. Operating out of coastal bases, they performed a herculean task in supplying Fleet and Marine units and in simplifying their logistics problems caused by the global war we were fighting. Those units were far-flung. The Navy had been assigned the major role in the Pacific while the Army had a similar role in North Africa and Europe.

Commercial Air Cargo. On Dec. 7, domestic airlines had owned 360 transport planes. By May 1942, the AAF and the Navy had requisitioned 184, and had left the balance frozen at the number available for regular use. When war broke out, the Armed Services also had requisitioned all the Douglas DC-4's airlines had on order.

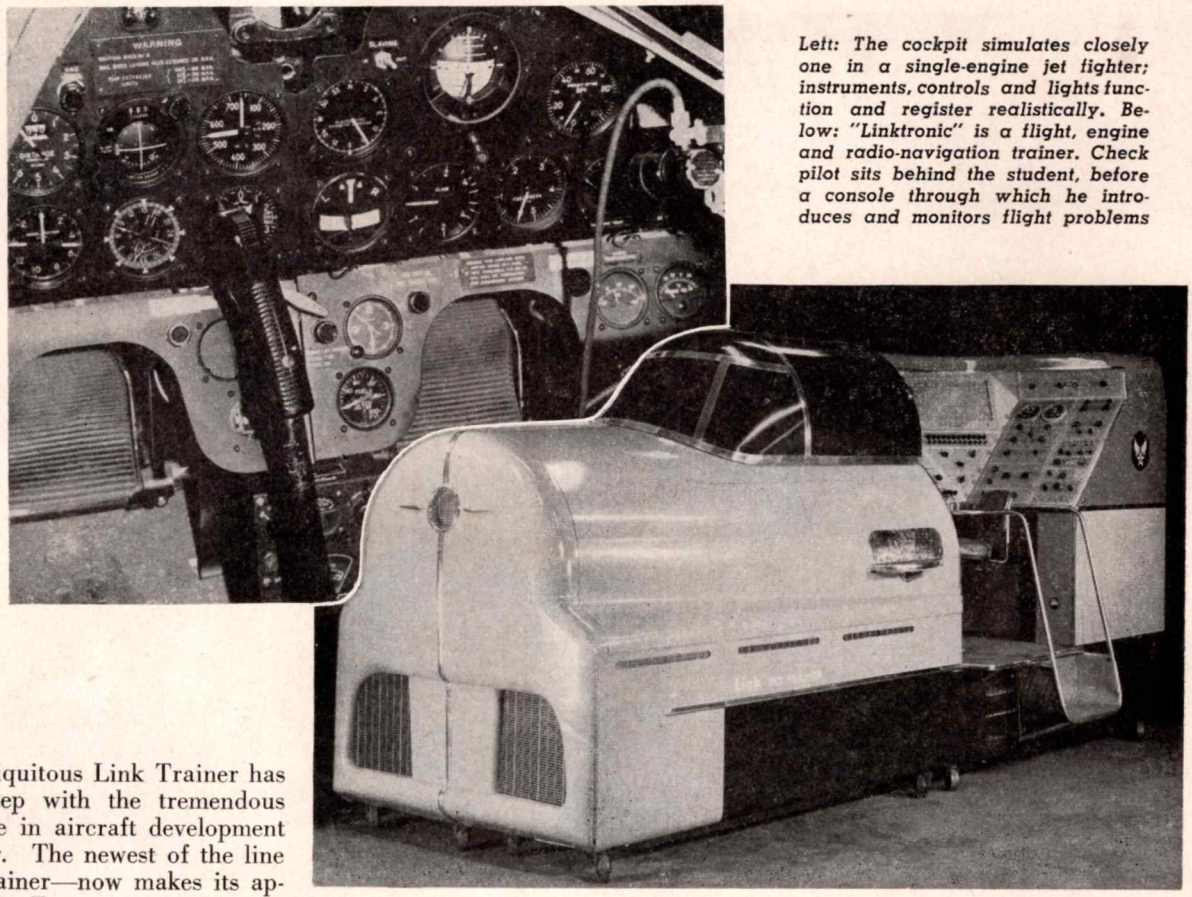
Shortly after this, the airlines contracted with the Government to furnish various services on a cost-plus basis. Among these were supplying civilian crews to man the planes leased to ATC and NATS, conducting flight and ground training of military personnel and the performance of ground services at ATC and NATS stops at civilian airports. During the war, the commercial airlines flew 850 million ton-miles of cargo under military contract in a global operation.

Scheduled air cargo, as such, was introduced by American Airlines, when, in October 1944, they made cargo service available over their entire system. By April 1945, the Government had begun to return some of the leased aircraft to the airlines and AAL inaugurated cargo service on their Mexico routes. Three months later, Transcontinental & Western Air, Inc. launched a limited service from New York to Los Angeles and, in January 1946, they extended it over their entire system. Braniff, Western, Continental and United next jumped on the bandwagon, to be followed by Capital and Chicago & Southern.

There are no statistics as regards ton-miles or route-miles of cargo flown during those early years, as the airlines reported cargo and express figures in one total. However, it is estimated by air-cargo specialists that the figure in 1945 was about 24 million ton-miles, and in 1946 about 120 million ton-miles. Compare these with the ATC and scheduled-cargo figures of 1940! *(Continued on page 100)*



Seaboard & Western Airlines pioneered in international all-cargo flights; has an impressive record in the transportation of large articles and domestic and wild animals



Left: The cockpit simulates closely one in a single-engine jet fighter; instruments, controls and lights function and register realistically. Below: "Linktronic" is a flight, engine and radio-navigation trainer. Check pilot sits behind the student, before a console through which he introduces and monitors flight problems

LINK FOR THE JETS

It's another miracle of the Air Age when student pilots can qualify for solo performance at even the new subsonic speeds without leaving the ground

THE ubiquitous Link Trainer has kept step with the tremendous advance in aircraft development since the war. The newest of the line —the Jet Trainer—now makes its appearance. Air Force jet pilots in the future will do their first high-speed "flying" in this electronic ground device.

Developed for the Air Material Command, by Link Aviation, Inc., *Linktronic* simulates jet-aircraft flight, combining training in techniques of flight and engine control and radio navigation. Both the student under the hood and his check pilot occupy places inside the new trainer. The instructor no longer checks a "crab" path across the top of a separate table.

Controls, instruments and indicators function just as they would in actual flight. Rates of roll, climb and acceleration are duplicates of similar aspects in high-speed plane performance, and the controls are loaded so that pressures vary with airspeed. An integral part of the new trainer is a series of emergency controls with which the check pilot, sitting behind the cockpit, can introduce a wide variety of operating troubles.

Flight conditions in the trainer may be varied from a thin overcast to night instrument conditions through the use of light-intensity controls. Wing and pitot icing can be simulated, and they affect both flight performances and instrument indications. The trainer also permits the introduction of rough air, its intensity governed by the instructor.

Because of the extensive amount of air work at high altitudes required in jets and their frequent use in the polar regions, wind effects become a major factor in this sort of navigation. The amount of wind velocity which can be introduced into *Linktronic* problems is more than twice that which was provided in previous Link Trainers.

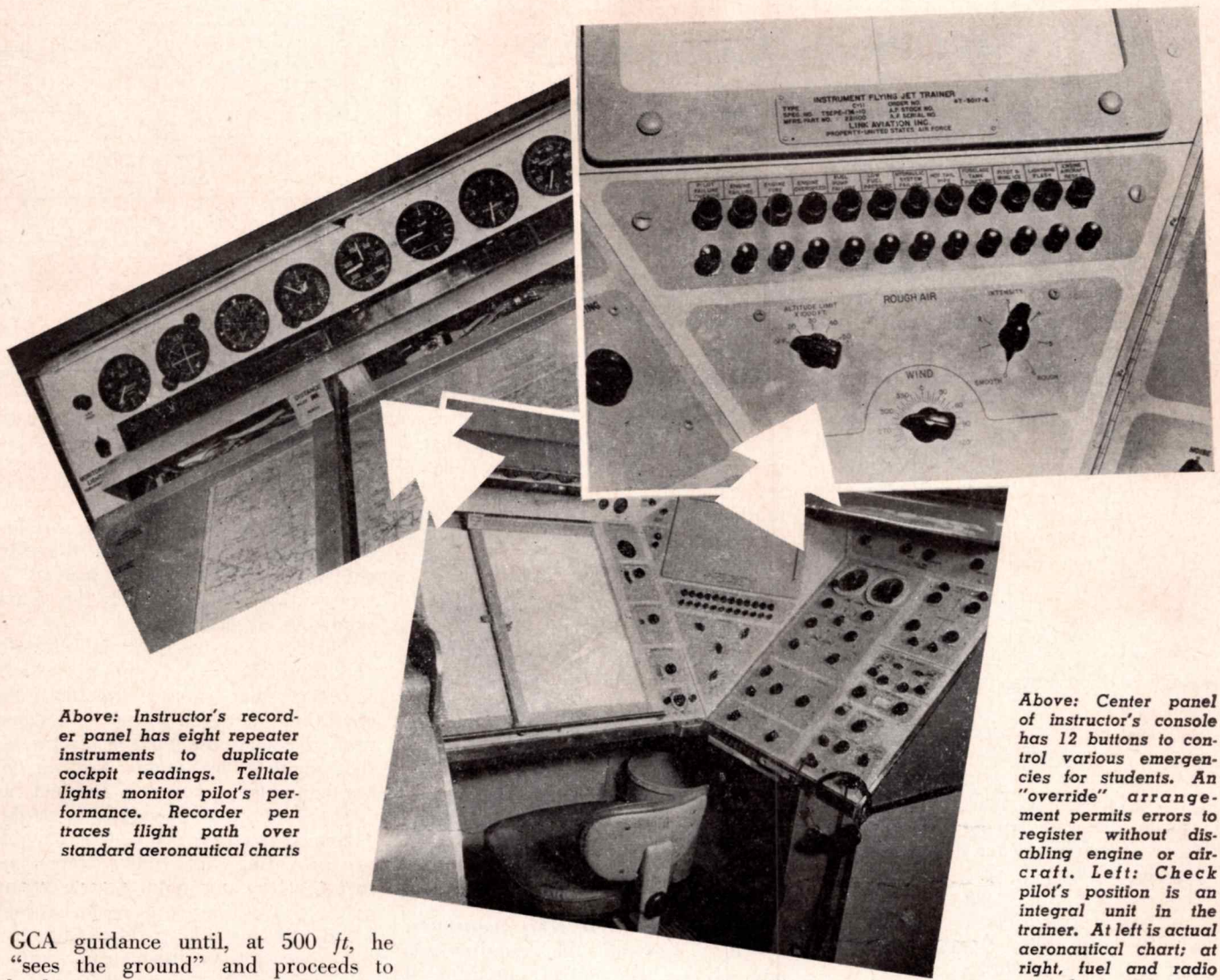
Once the student is under the hood, the check pilot puts him through his problems. He reacts to instructions which appear on the instrument panel as regular flight, or emergency operations that might face any pilot in actual high-speed flight.

Eventful Trip

For example, an instructor might set up a problem such as this: A student under the hood in the Trainer is cruising at 35,000 *ft*, when suddenly the check pilot presses a button marked "fuel-pump failure." The engine stops; the student glides below 20,000 *ft* to attempt an air start. He follows proper starting procedure, but, when the engine refuses to respond, he presumes that his main fuel pump has failed and glides to an altitude where he can use his emergency fuel pump. He reduces the airspeed to less than 300 *mph*, turns the emergency fuel pump to the "On" position, cracks the throttle and the engine then starts.

Just as he gets the engine going, the check pilot punches another button and the fuselage tank is punctured by a burst of flak. The student switches his fuel flow to bypass the fuselage tank and heads for the airport. As he starts his approach to the field, he encounters a mythical thunderstorm. Lighting flashes light the cockpit and the plane is buffeted by considerable turbulence.

Finally, as he starts the landing procedure, the check pilot puts him into one last predicament by causing his hydraulic system to fail. With wing flaps inoperative, the student lowers his landing gear manually, follows



Above: Instructor's recorder panel has eight repeater instruments to duplicate cockpit readings. Telltale lights monitor pilot's performance. Recorder pen traces flight path over standard aeronautical charts

Above: Center panel of instructor's console has 12 buttons to control various emergencies for students. An "override" arrangement permits errors to register without disabling engine or aircraft. Left: Check pilot's position is an integral unit in the trainer. At left is actual aeronautical chart; at right, fuel and radio controls

GCA guidance until, at 500 *ft*, he "sees the ground" and proceeds to land.

If by chance a fledgling pilot should become hopelessly confused in an emergency and fail to respond with the proper procedure, the check pilot can press a so-called "angelic switch" which clears the board of all troubles and allows the pilot to start his problem over again.

Turbojet engines must be operated within highly critical limits which are present from the time the engine starts until it stops.

In the Link Jet Trainer, the pilot must follow to the letter the procedures and sequences for operating his engine. These sequences are monitored by an electronic watchdog which causes "failure" to occur automatically if the pilot errs in controlling the engine. The errors, and their causes, are indicated to the check pilot through a series of 23 colored lights on his console. Red lights indicate an error in technique, amber lights the result of the error, and blue lights show the operating condition of the airplane.

For example, the student makes a start, but releases his starter button before the engine reaches 17% *rpm*. At once the red "Starter OFF" telltale light flashes on. Likewise, the "Engine OFF" light flashes in blue and, unless he makes an immediate correction, the amber "Engine Disabled" light will appear also.

The navigational facilities available in the Jet Trainer are highly important. It is possible to give a pilot instruction in the use of VHF, omnirange and the off-set course computers which are coming into use under the Air Navigation Development Board Interim Facilities Program.

Navigation Aids

The facilities in the *Linktronic* include a Radio Magnetic Indicator, Distance-Measuring Equipment, an ID-249 Cross-Pointer Indicator and an Arbitrary Course Computer. These enable a pilot to determine his position and course through visual reference to instruments rather than through aural signals, as is the case with older, low-frequency equipment. Low-frequency controls are provided, however, for radio compass and aural null procedures.

The instructor's console provides two station locators with all necessary controls for setting in type of station, frequency, call letters, maximum range and approach bearing. By resetting Station No. 1 as Station No. 3 as soon as the pilot has tuned to Station No. 2, the instructor can simulate an infinite number of radio stations and make possible cross-country flights of more than 1000 miles. Once the stations have been set at proper geographic locations, all signal transmissions are automatic, and the check pilot has only to simulate such voice communications as he chooses.

By means of duplicate instruments (RMI, DME, ID-249 and Altimeter), the instructor also can follow a student's performance on ILS approaches. Possessing this range, azimuth and elevation information, he can then give practice in standardized GCA letdown procedure.

A constant record of the pilot's flight path is maintained by a new-type automatic recorder located on the

(Continued on page 99)

TURBOPROP CONTROLS*

GEORGE P. KNAPP
Project Engineer, Propeller Division, Curtiss-Wright Corp.

SOMETIMES, in the development of new devices, the determination of the detailed design requirements and performance specifications becomes a task comparable with that of making the design itself. This has been true in the case of turboprop-control development.

Among the functional requirements are those characteristics which protect the powerplant against operation outside its ratings. These include control of thrust, without objectionable transients; continuity of control-quadrant calibration, with the full stroke of the power lever always available and effective in changing power setting; ability to obtain essentially zero net thrust at one fixed-power lever setting; and convenient provision for starting, feathering and reverse-pitch operation.

Since these requirements must be met by regulation of only two quantities, fuel flow and propeller-blade angle, it is obvious that not all of the parameters can be controlled at the same time. This means that the control should be able to shift automatically from one regime to another, to control which ever quantities happen to be the most critical under the existing operation conditions.

Control Quadrant.—Before a study can be made of the quantities to be controlled as conditions change, it is necessary to look at the conditions imposed by the pilot's control quadrant. One of the features of this quadrant is a condition lever, setting up the values or schedules of power and *rpm* required for each operating condition. Typical requirements for the five conditions are shown in *Table 1*. In this tabulation, the minimum power point is the one at which essentially zero net thrust should be obtained.

The control quadrant includes also a power lever which is effective in the last two conditions, *Operation Idle* and *Combat and Land*. This lever constitutes the pilot's main power control, varying power by scheduling the setting of which ever two of the controllable parameters (*rpm*, temperature, torque, thrust, blade angle or fuel flow) are to be controlled.

In the *Operation Idle* condition shown in Table 1, *rpm* is controlled over a relatively narrow range near maximum *rpm*, while power is varied over its full range. The schedule is set generally to provide essentially minimum fuel consumption for each power setting. Reverse thrust is not obtainable in this position of the condition lever.

In the *Combat and Land* position, power is again variable over its full range, but *rpm* is held constant at its maximum setting to permit rapid power recovery. Reverse thrust is obtainable in this condition. Some thought is being given currently toward omitting this condition in the case of turbines which can accelerate rapidly. In this case, reverse thrust would be made available in the *Operation Idle* condition.

Detailed Control Requirements.—After studying the requirements imposed by the control quadrant, it becomes necessary next to look at the inherent characteristics of the turbine and propeller to determine how the requirements can best be met.

Looking first at the turbine, it is noted that power output increases rapidly with burner temperature, and also that maximum power output increases rapidly with *rpm*. The ability to set and maintain temperature and *rpm* at their maximum permissible values is therefore of great importance. It is characteristic of turboprop engines also to exhibit a wide variation of shaft torque at maximum temperature, as flight conditions vary. In some flight conditions, especially high-speed, low-altitude flight on a cold day, the torque obtained at maximum burner temperature substantially exceeds the rating of the engine's reduction gearing. Torque must therefore sometimes be controlled instead of temperature, at and near the maximum power setting.

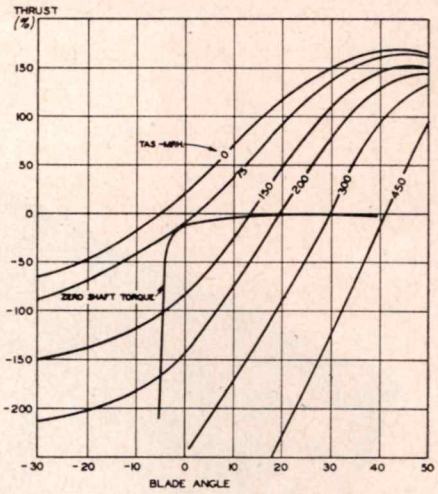


Figure 1

Furthermore, the control preferably should not be of the topping or limiting type, but should anticipate the conditions at which torque or temperature becomes the limiting factor, so that neither maximum torque nor maximum temperature is reached before the end of the power-lever stroke.

Since the control should be capable of providing essentially zero net thrust at the minimum power setting of the power lever, this could be done ideally by controlling thrust directly; but since present turboprop engines are not equipped with thrustmeters, some other means must be found. Burner temperature is not a suitable quantity for this purpose, since the burner temperature at which zero thrust is obtained varies widely with flight conditions. A means of obtaining the desired result at medium to high airspeeds is suggested by *Fig 1*, which is a typical plot of thrust versus propeller-blade angle at constant *rpm*.

Also plotted on this curve is the line of zero shaft torque. This indicates that, above about 100 *rpm*, torque control can be used to obtain zero thrust. Since a torquemeter is available on most turboprop powerplants, torque control is practical under these flight conditions. At low speeds and at standstill, however, torque control becomes impossible because of the inability to obtain zero torque and the reversal in slope of the torque curves as indicated in *fig 2*.

It is therefore necessary at the lower airspeeds to resort to another method, such as an open-cycle control of blade angle—that is, a control which sets the propeller to a blade angle predetermined to be the one which produces

TABLE 1

Condition	RPM (% of Max.)	Power (% of Max.)	Comments
Stop	0	0	Fuel Off and Propeller Feather
Start	0—60	0—Min	Fuel Controlled for Starting and Propeller at Min. Torque Angle
Ground Idle	60	Min	Propeller at Min. Torque Angle
Operation Idle	80—100	Min—100	
Combat & Land	100	Min—100 and Reverse	

* Condensed from a paper presented at the Annual Meeting of the SAE at Detroit, Mich., Jan. 1950.

zero thrust. Modulated braking action at landing airspeeds may then be obtained by decreasing the blade-angle setting as the power lever is moved into the reverse-thrust region. This method of controlling reverse thrust is suitable only for landing airspeeds and below. The expected inaccuracies of a blade-angle computer would make the method impractical at high airspeeds where the range of blade angle between zero and maximum power may be only three or four degrees.

If braking at higher airspeeds is wanted, further difficulties are encountered. If an attempt is made to apply aerodynamic braking by operating in the windmilling region, it is found that very little drag is obtained before an overspeed is reached, even with no fuel supplied to the turbine. On the other hand, if an attempt is made to pass through the windmilling region rapidly to avoid overspeeding, excessive torque is applied to the reduction gearing because of the characteristically high inertia of the turbine.

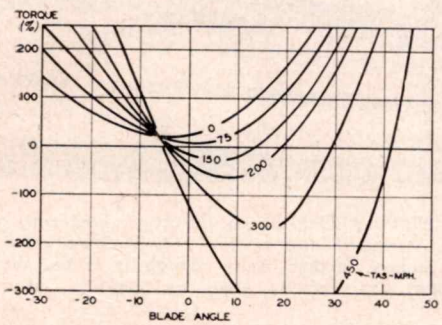


Figure 2

The Case for the Fuel-Flow Governor.—It is necessary next to decide which functions are to be obtained by control of blade angle and which by control of fuel flow. This really boils down to a decision between a propeller blade-angle governor and a turbine fuel-flow governor. Either can result in a stable, fast-acting control. In past experience with reciprocating engines, governing by means of the propeller has been practically universal. In this case, however, new control requirements and different turbine characteristics from those of reciprocating engines warrant a reappraisal of past practices.

As noted earlier, under certain conditions, *rpm* and thrust should be controlled simultaneously. Lacking a thrustmeter and at low airspeeds, the most practical means of controlling thrust appears to be a direct control of blade angle. Furthermore, near the zero-thrust angle, *rpm* cannot be controlled by a propeller governor. This

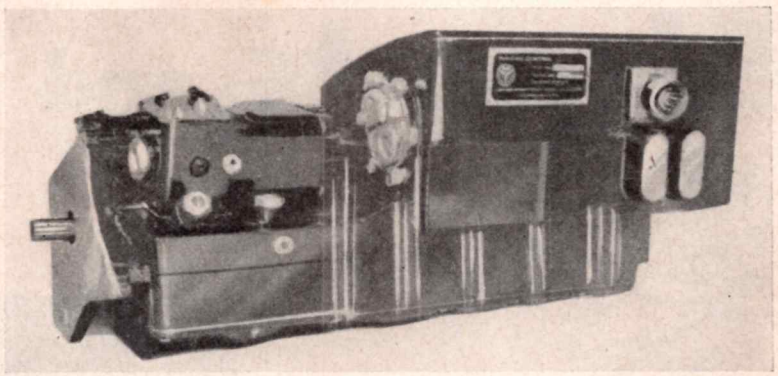


Figure 3

makes it necessary to use a governor operating upon fuel flow. This type of governor always can be effective, since a decrease in fuel always tends to reduce *rpm*. The addition of a separate governor for the propeller would seem to be an unnecessary duplication.

Selecting Control Sensitivities.—The next step in the design is the selection of a set of control sensitivities which will provide stable and rapid control operation. If a sudden change in either fuel flow or blade angle is made for turboprops with all other factors held constant, they take a longer time to approach their new equilibrium speed than a reciprocating engine would. The reason for this is their relatively high ratio of stored energy to power output. Because of this, a simple proportional governor which causes a rate of change of fuel flow proportional to *rpm* error would have to have an extremely low sensitivity to avoid unstabilizing the system. A sudden power reduction would produce a relatively large overspeed which might take several seconds to disappear.

Since the requirement for holding *rpm* in a turbine powerplant is more stringent than in a reciprocating engine, it is necessary to neutralize the effect of this time lag by incorporating acceleration sensitivity, or its equivalent, in the governor. Temporary droop-stabilized, isochronous governors can provide the required stabilization, and their design has been well developed in previous applications.

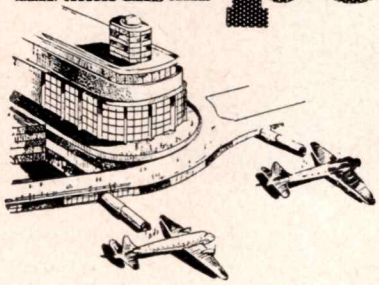
Three fundamental parameters are involved in the design of governors of this type, and all of these factors must be determined approximately before the governor can be designed. The three quantities involved are droop sensitivity, reset sensitivity and governor characteristic time of response. Assuming a linear system with no

(Continued on page 93)

Glossary

Symbol		
ΔW_f	Change in fuel flow	*lbs/hr*
ΔN	Change in RPM	(minutes)$^{-1}$
$\Delta\beta$	Change in blade angle	degrees
ΔQ	Change in torque	*lb-ft*
ΔT	Change in burner temperature	°Rankine
ΔN_o	Change in governor setting	*rpm*
ΔQ_o	Change in torque control setting	*lb-ft*
ΔT_o	Change in temperature control setting	°Rankine
τ	Power plant characteristic time	seconds
τ_s	Governor characteristic time	seconds
n_G	Governor reset sensitivity	*lbs/hr/sec/rpm* error
k_D	Governor droop sensitivity	*lbs/hr/rpm* error
n_Q	Torque control sensitivity	$°\beta/sec/lb\text{-}ft$ torque error
n_T	Temperature control sensitivity	$°\beta/sec/°R$ temperature error
a	Change of equilibrium RPM with blade angle	$\frac{\partial N_e}{\partial \beta}$
b	Change of equilibrium RPM with fuel flow	$\frac{\partial N_e}{\partial w_f}$
c	Change of burner temperature with fuel flow	$\frac{\partial T}{\partial W_f}$
d	Change of burner temperature with RPM	$\frac{\partial T}{\partial N}$
c_Q	Change of steady state shaft torque with fuel flow	$\frac{\partial Q_e}{\partial w_f}$
d_Q	Change of steady state shaft torque with RPM	$\frac{\partial Q_e}{\partial N}$
μ	Ratio of turbine and compression inertia to total inertia	Dimensionless
p	Differential operator $\frac{d}{dt}$	(seconds)$^{-1}$
$\frac{1}{p}$	Integral operator $\int dt$	seconds

Airports and Airways



Milwaukee's Maitland Field is on the city's lakefront, adjacent to a railroad terminal and within a five-minute drive of the downtown business section. Even though it is not paying its way presently, the citizens keep on making improvements

MILWAUKEE'S "CIVIC" AIRPORT

Three Years Later!

FRANCIS J. TRECKER

Aviation Chairman, Greater Milwaukee Committee

EARLY in November of 1949, a small plane set down after dark on Milwaukee's Maitland Field. The landing, part of the promotion of a Christmas festival, was the first night landing in the field's history. Even though Maitland still has no equipment for night landings, even though temporary facilities were set up to help the "Santa Claus" plane down, that landing was another important milestone in the history of Milwaukee's Maitland Field, the first "downtown" airplane facility in any metropolitan area.

As far back as August 1946, the Civil Aeronautics Administration and the aviation world as a whole were watching with deep interest Milwaukee's experiment in downtown aviation facilities. It was said, then, that Maitland Field had tremendous possibilities (AERO DIGEST, August 1946). Now, better than three years later, Milwaukee offers another report on its struggle to build a useful, efficient downtown airfield.

The report is a mixture of progress and setbacks, of disappointments and hope for the future. Nevertheless, the theme is one of optimism.

Prominent in any report that can be made of Maitland Field is a volunteer civic organization called the Greater Milwaukee Committee for Community Development—three-score of the community's top executives, banded together for civic improvement that is expected to make Milwaukee the equal of any other city in the nation. The Maitland Field project is relatively small, but when compared with the multi-million dollar traffic, educational and parking projects being sponsored by the group, the aviation facility has proved a source of satisfaction to the members. Whenever the project has been placed before official groups of the city government, Greater Milwaukee Committee members have appeared to propound the cause of progress and achievement.

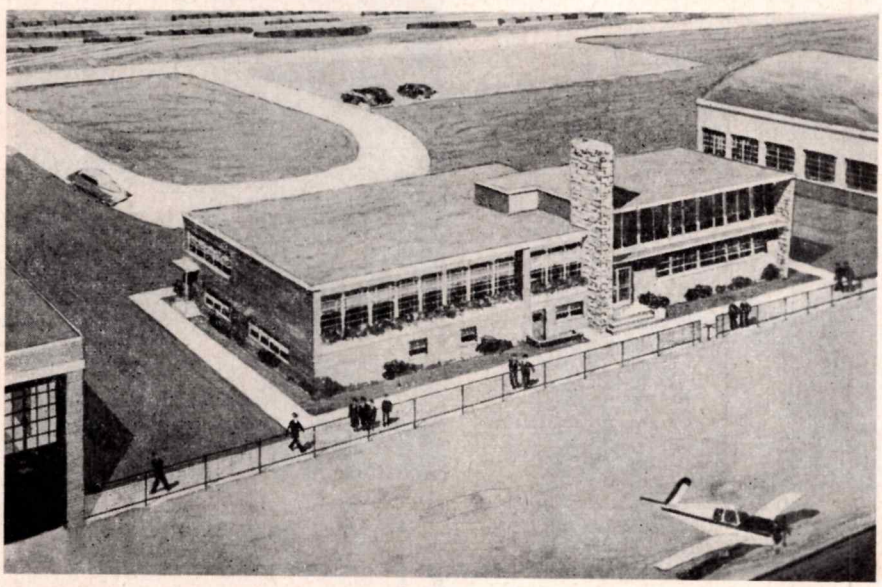
Here, briefly, is the present picture of Maitland Field—the downtown airport located on the lakefront at the eastern end of Wisconsin Avenue, Milwaukee's main street, three blocks from the Federal Building and Post Office and only six blocks from the center of downtown Milwaukee:

1. A $212,000 first-stage development program has been completed, with most of the money being expended for a 2900-*ft* hard-surface runway and parallel taxi strip
2. A commercial firm, Skymotive-Milwaukee, Inc., is now operating the airstrip
3. A $129,000 second-stage development program is ready to get underway. The program is to include construction of a modern $40,000 administration building, rebuilding of the seaplane ramp, widening and repaving of the road west of the field and additional drainage, utility installation and landscaping.

These are the most important steps of progress that have been witnessed so far. Milwaukee is determined that there will be many more to come.

Whatever the state of conditions now or the prospects for the future, Maitland's beginnings were not par-

Wisconsin's big city on Lake Michigan has been having its troubles in developing an air terminal on the harbor side, but progress is being made towards a happy realization



Sketch of administration building to be erected this year. A local operator runs airport services; expects eventually to erect suitable hangars and shops

ticularly spectacular. The idea for a downtown airfield, like Topsy, just seemed to grow, without pattern, without specific plan. The field was discovered by the Kohler brothers, who flew amphibians from Milwaukee to Detroit and used Maitland for their water landing ramp and then the field itself, on conversion to wheels. As early as 1928, when the U. S. Postal Department indicated it would like to make use of the port as an air-mail landing strip if its facilities were improved, Milwaukeeans began to believe that their downtown landing strip might be of real value some day.

Development, however, languished. The field was relatively inactive between the years 1931 and 1937, when Milwaukee harbor officials refused to surrender the land for airport purposes. "This land," they said, "was created for harbor purposes, and it must be retained for that purpose."

But Maitland's progress was not to be denied, even though it was slow in coming. By 1930, Milwaukee's harbor commission had approved construction of a taxiway from amphibian ramp to the Northwestern Railway station and the Milwaukee *Journal* reported that ". . . no other large city is said to have the natural advantage presented in Milwaukee, by which an airplane can taxi up to a railroad terminal and discharge its passengers within a few feet of a waiting train."

It Grew Anyway

Despite sporadic objections that the field was too narrow as a terminal for all types of transportation and that increasing its size would interfere with over-all development of Milwaukee's harbor, improvements continued to be seen at Maitland. In 1931, a new amphibian ramp was dedicated with ceremony and, in 1937, the field, after a period of idleness, was reopened formally to commercial aviation.

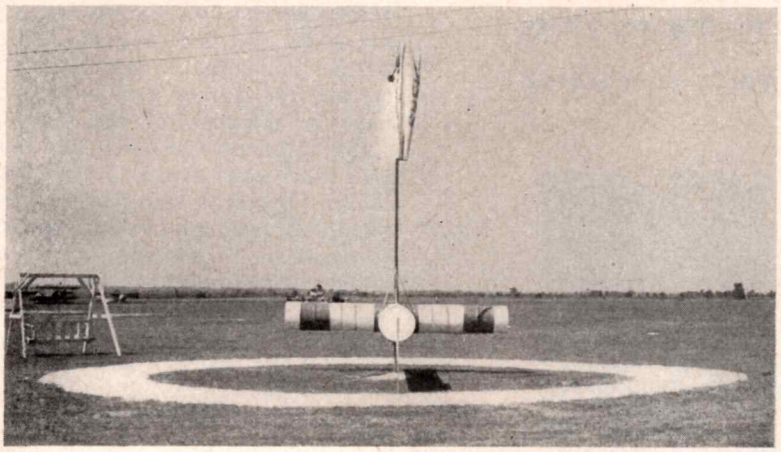
It was in 1946, however, that Maitland got a real "shot in the arm." That was the year Milwaukee held its "Centurama" celebration in commemoration of the city's 100th birthday. In the 31 days of the celebration, some 3500 landings and takeoffs were made from the airstrip and seadrome. The comments of visiting flyers and officials were particularly interesting. "Milwaukee has a wonderful thing in its Maitland Field," said one visiting official. "It is an advantage which no other city in America possesses. The usefulness of the strip was amply demonstrated during the show."

Many Milwaukeeans believe that it was comments like these which prompted the adoption, in 1947, of a ten-year experimental plan for the improvement of Maitland field—the most comprehensive and far-seeing plan yet to affect its fortunes.

In all truth, it must be stated that progress at the downtown field has not been made without difficulty, or without cost. There are still in Milwaukee those who doubt that the downtown field ever will be as useful as its more ardent supporters maintain. They say that the field's area is too small, that it is fringed by too many obstructions, that visibility and atmospheric condi-

(Continued on page 84)

AIRPORT SHORTS



Low-Cost Oil-Drum Wind Tee

THE outlay for materials for this small airport wind-tee and sock combination was only $30. The airport operator did his own welding and other construction work, while the wind sock was supplied by an oil company.

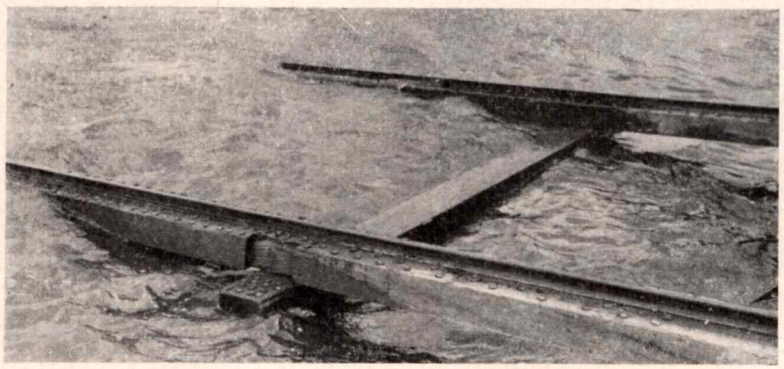
The tee was constructed by welding together eleven discarded 55-*gal* oil drums. Six drums were used for the long section and five for the shorter or "wing" section, making the tee approximately 17½ x 15 *ft.*

Used to support the tee is a 2-*in* welded angle-iron frame having ½-*in* steel plate drilled to fit a steel-pipe axle imbedded solidly in a concrete foundation. A 16-gage sheet steel fin, 6 *ft* long and 2 *ft* high, was welded on top the "tail." The fin was reinforced at the edges by ½-*in* rod supports. About 150 *lbs* of sand were put in the center barrel of the "wing" to provide the proper balance.

A steel rod at the rear of the tee may be lowered or raised in order that the tee may be used as either a fixed traffic indicator or as a free-swinging indicator. In the lowered position, the rod engages pipe sleeves imbedded in the ground and aligned with the landing strips.

The tee is painted with alternate international orange-and-white striping to make it easy to see both in the air and on the ground. The sock is mounted on a steel pipe extending up through the drum from the supporting axle. A 4-*ft* wide, white concrete circle marker, about 50 *ft* in diameter, around the base of the tee provides additional marking and makes it easier to spot from the air.

This device was constructed at Doc's Airpark, Taylor, Mo., from plans designed by the engineering department of the Aviation Section, Missouri Division of Resources and Development at Jefferson City, under the direction of Lee Lamar, airport engineer.

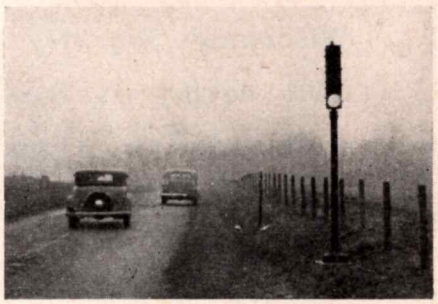


Bottle-Top Grips for Seaplane Ramps

UPTURNED soft-drink and beer-bottle tops nailed atop the wooden members of seaplane ramps will provide an excellent non-slip surface for walking.

Claude Dilworth, owner and operator of the Dobbs Ferry, (N. Y.) Seaplane Base, found that something had to be done to prevent pilots and dockmen from slipping on the wooden members alongside the seaplane dolly tracks which tide and wind frequently cover with water. He was worried not only about the dunking, but a fall on the iron tracks could be very serious.

One day his Chief Pilot-Instructor Ronald R. Beaulieu, who is also a certified A&E mechanic, came up with the bottle-top idea and, ever since, all such tops are saved for this useful purpose. The cork in the tops as well as the ragged edges provides the desired non-skid traction.

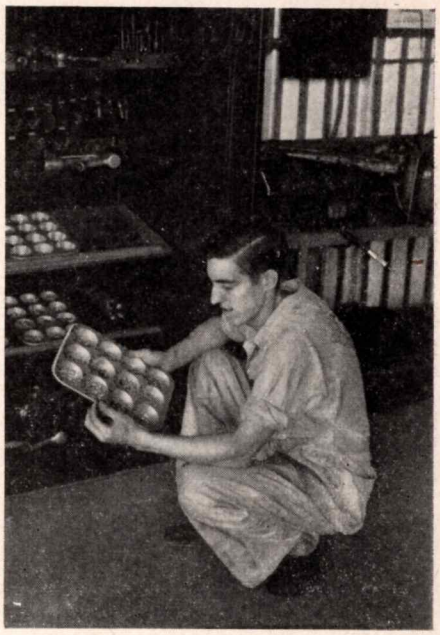


Traffic Lights Protect Approach Zones

TRAFFIC signal lights installed on streets and roadways crossing airport approach zones not only will increase safety of operations but surely will help also to relieve pilot tension in landing planes.

They are especially important where roadways immediately adjoin the airport boundary—which is usually the case. It is helpful also to install warning signs along the roadways, advising motorists to watch out for planes and to expect the traffic lights ahead.

The lights should be operated, of course, from the control tower. In installation, they should be sufficiently removed from the approach zones so that they do not form an additional obstruction to the aircraft.



Muffin Pans Save Steps

ORDINARY home kitchen-type muffin pans make excellent receptacles for small quantities of nuts, bolts, rivets, washers and other small parts. By keeping them in the tool cabinet in the shop, a great many steps are saved daily in making trips to the stock room for the small but frequently needed items they hold so conveniently.

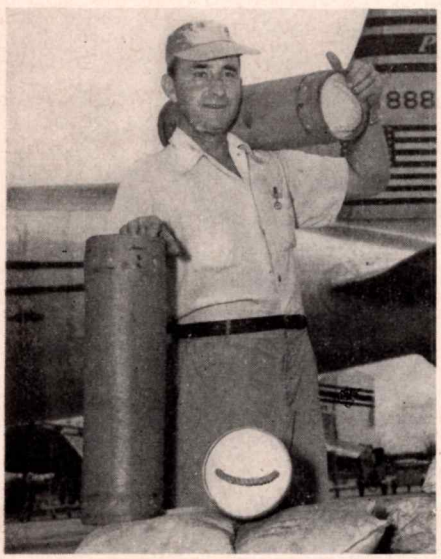
They are easily stored and handy to remove for selecting the desired size nut, bolt, etc.

John Kesselring, sheet metal mechanic at Atlantic Aviation Corp., Teterboro, N. J., suggested this time-saving idea.

Fire-Hose Sections Hold Ballast

THE answer to a long-standing ballast problem has been found. To substitute for passenger weight on pilot-training flights, Pan American World Airways' *Clippers* take aboard ballast to simulate a payload. Heretofore, this ballast consisted of 50-*lb* canvas sandbags. The bags leaked sand and sometimes burst, and loading 100 or more of them was a back-breaking job.

Asa C. Potter, master mechanic for PAA at Miami, remedied this situation by making sand containers out of sections of fire hose, each 2 *ft* long and weighing about 33 *lbs* when filled. Wooden plugs were used to seal the ends, and a rope loop in the plug made a convenient handle.

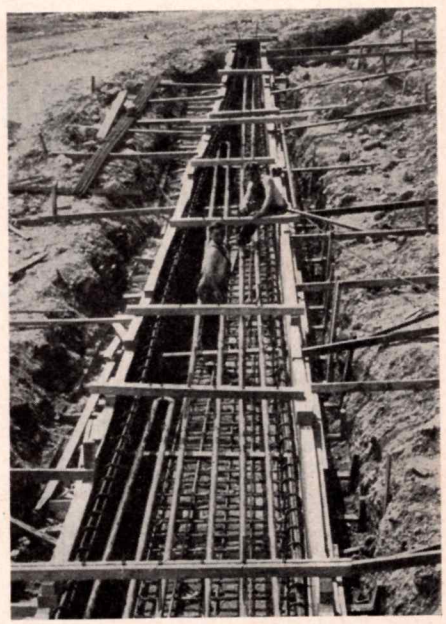


The hose containers last much longer than the ordinary sandbags and their lighter weight means fewer backaches. Potter is shown with the fire hose containers he devised. Below, for comparison, are shown the 50-*lb* canvas sandbags.

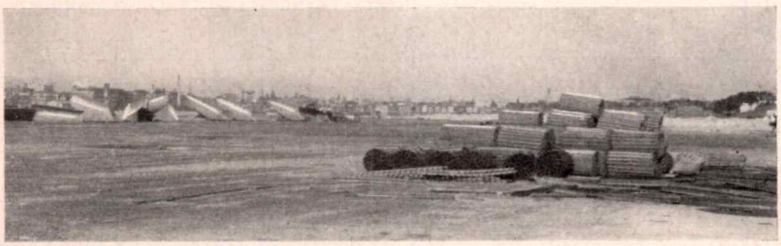
Pipes Keep Hangar Door Ice-Free

A SYSTEM of wrought-iron pipes, carrying hot water and imbedded in the pavement beneath the doors of American Airlines' new hangars at Chicago Municipal Airport, keeps a 7-*ft* wide strip of concrete at the base of the doors free of ice and snow interference throughout the winter months.

The melting system, consisting of nearly two miles of 2 and 2½-*in* pipe, is fed hot water from a boiler in the hangar, the water returning to the boiler to be reheated and recirculated after coursing through the serpentine coils of the system. Anti-freeze is added in anticipation of emergencies when the boiler might be cold. Supply and return mains serve respectively as arteries and veins of the system, and the water is re-used continually throughout the critical season.



The picture shows workmen installing the heating pipes prior to the pouring of concrete.



Snow Fence Prevents Drifting

SNOW FENCE used at airports reduces or prevents drifting. In locations where snowfall is heavy and drifting conditions are likely to be serious, two or more parallel rows of snow fence placed 50-100 *ft* apart are very effective.

Picture shows snow fence piled at the Logan International Airport, Boston, Mass., after receiving a protective coating of paint.

Normally, a light snow, or a fall of moderate depth, in itself does not stop operations of aircraft. However, sometimes during a snowstorm—and invariably when the weather clears—a stiff wind sets in and begins drifting the fallen flakes.

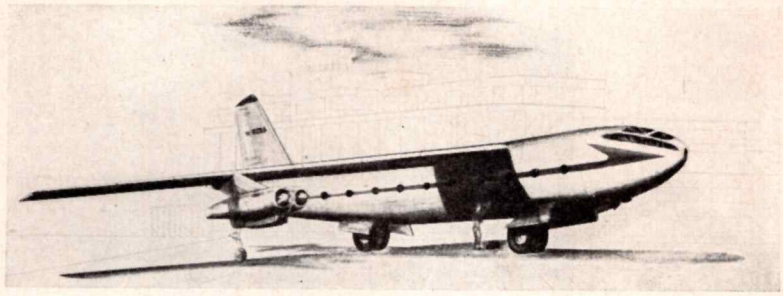
Even though the drift may not be directly across the main runway, there are usually some accumulations at spots along the landing strip and taxiways which constitute a real danger. The relatively cheap snow fence, screening such potential danger areas—even if there is little use for it during a normal winter—may make it unnecessary to maintain expensive snow-removal equipment, which the small airport budget cannot afford in the first place.

Flying Treasure Hunt

KENTUCKY AIR TRANSPORT, INC., fixed-base operator at Louisville, Ky., has held a series of aviation treasure hunts to stimulate interest in personal flying during the winter months. Even in the southland, many aircraft owners consider flying a summer activity; but J. B. Wathen of KAT believes that his plan will demonstrate that today's aircraft have year-round utility.

According to the rules, a pilot opens a sealed envelope after he takes off and gets a clue to his first check point, at which he lands. At each point, he receives an additional clue to the next point and, if he's "on the ball" intellectually and navigation-wise, he can complete the circuit in less than 2½ *hrs.* Aircraft are handicapped according to manufacturer's performance characteristics, thus eliminating any design advantages.

After the last aircraft has completed the course, prizes are awarded to the winners and a party is given by KAT for all participants. Another good example of "progressive promotion."



Boeing design for future jet transport. Similar to B-47, 40-passenger, 500-mph transport will be powered by four turbojets, have tandem gear, sweptback surfaces and operate from present airports

NOTES ON PNEUMATICS*

Part 2

EUGENE STOLARIK

Associate Professor of Aeronautical Engineering, University of Minnesota

THE designs of pneumatic resistors used in our experiments were based on the resistance of flow through parallel plates. Each model was composed of 201 plates of two types. The flow plate had a slot .005 *in* thick, 1/32 *in* wide, and 3/4 *in* long. The other was a transfer plate, necessary for changing the direction of the path, *fig. 12*. By alternating these plates and stacking them atop each other, we were able to obtain a capillary path of high pneumatic resistance.

After assembling the plates, they were compressed by hydraulic pressure to eliminate possible side leakage. A cylindrical rod, operated by a micrometer, varied the number of plates engaged in forming the capillary path, resulting in longer or shorter paths of higher or lower resistance.

The first properties to be investigated were the pneumatic resistor's flow characteristics with varying pressure drops. Although the functional relationship, as indicated in *fig. 13*, is not perfectly linear through the whole range, the curve shows the linearity in the range of pressure drops between 1.5 to 10 *in* of mercury. Inasmuch as the practical maximum pressure drop is less than 5 *in* of mercury, the assumption of linearity for practical use is justified.

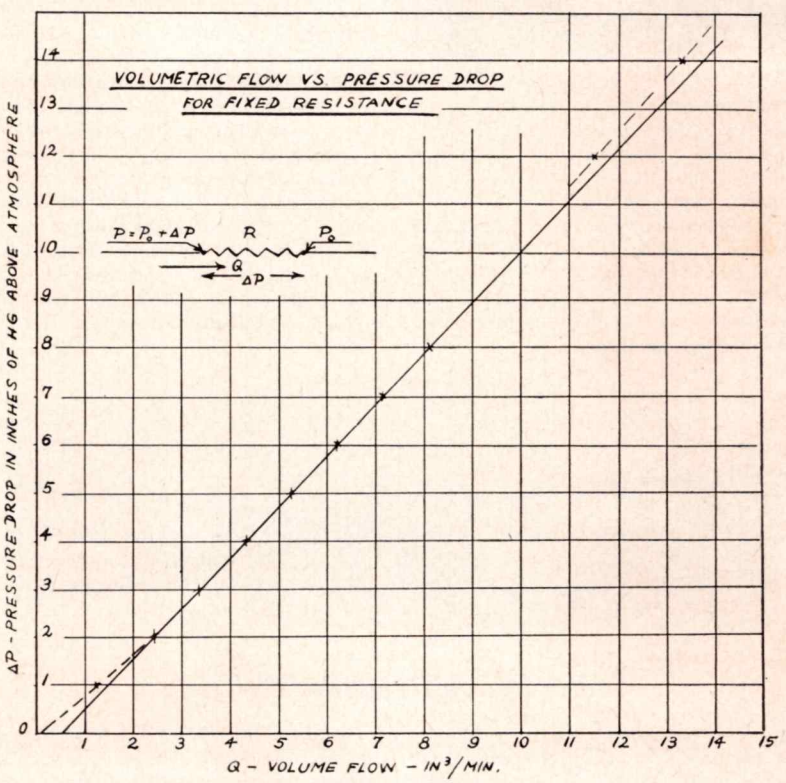


Figure 12

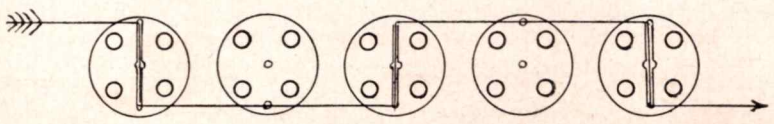


Figure 13

* Part 1 appeared in AERO DIGEST, Jan., 1950.

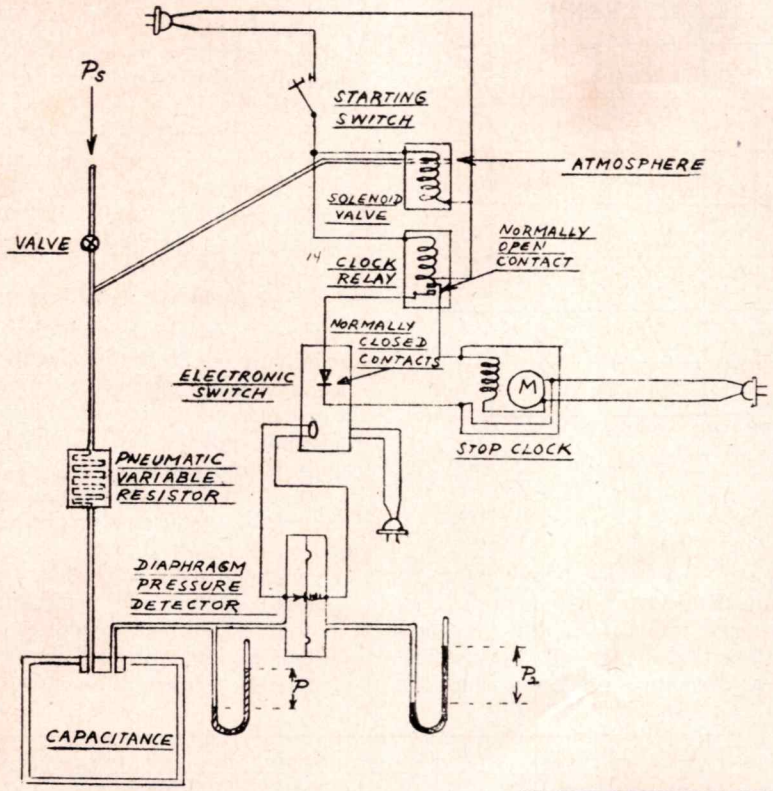


Figure 14

To obtain flow measurements at high pneumatic resistances, the flask water-displacement method was used. In measuring the flow characteristics of the pneumatic resistor when open entirely, a wet-test gas meter was employed, and the flow-versus-pressure-drop curve exhibited an orifice flow curve.

Measurement Method

The method used to study and measure the characteristics of pneumatic RC circuits is illustrated in *fig. 14*. This method employs an RC circuit consisting of a flask, acting as a capacitance, discharging through a pneumatic variable resistor. The apparatus was connected so that, when the capacitance was charged to a desired pressure P, the pressure supply P_S could be shut off and later opened to the atmosphere by a solenoid valve operated by a switch, which, at the same time, started an interval timing clock. The pressure detector incorporated in the circuit was used to detect the pressure departure from applied pressure inside the capacitance.

Then, in order to measure an RC time constant or the time of the transient phenomena of any RC circuit, one side of the pressure detector was set to a desired pressure P_2, which in the case of an RC time constant is equal to e^{-1} P, or, in measuring the time it took for the pressure P inside the capacitance to drop to any predetermined pressure P_2. This time interval was registered by a clock, which was turned on the same time the solenoid valve was opened to atmosphere and turned off when the pressure P dropped to P_2 inside the pneumatic pressure detector. When $P = P_2$, the detector's electrical contacts opened, stopping the clock.

Another Device

An alternate type of measuring apparatus, using a U-tube manometer detector instead of a diaphragm-operated one, also was employed. The U-tube detector is a manometer with one of the leads from the electronic switch acting as an electrode inside of one leg of the manometer, and the other lead from the electronic switch grounded on the other leg of the manometer. By this means, the clock registered exactly the time interval it took for the pressure P inside the capacitance to drop to pressure P_2. The time constant measurements, as

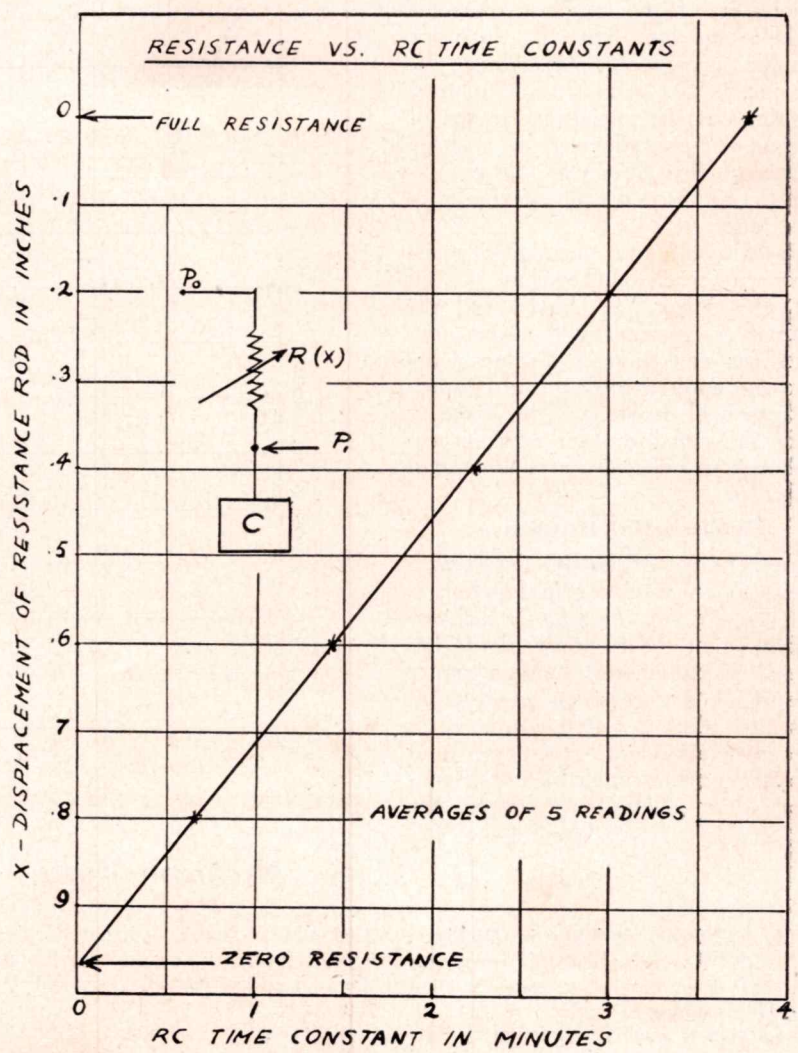


Figure 15

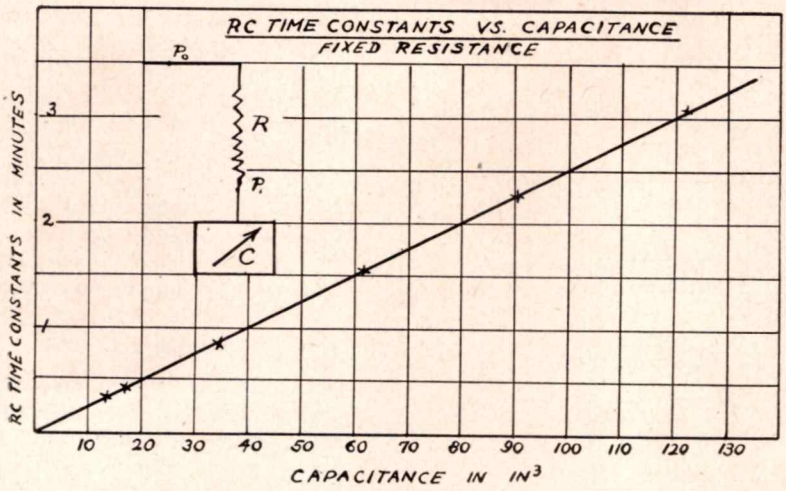


Figure 16

well as the time measurements of the transient phenomena, through this method produced very accurate results.

This method is subject to the effect of variable capacitance caused by changes of the manometer levels. Therefore, it is advisable to use a manometer of the smallest diameter available and large capacity, in order to make the variable capacitance effects negligible. It may be of interest to point out the variation in capacitance in our experiments, due to level changes of the manometer, did not exceed 0.3 of 1 per cent of the total capacitance.

Linearity of the pneumatic resistance with rod displacement is well illustrated in *fig. 15*. This curve was obtained by measuring the time constants for various rod displacements when the applied pressure and capacity were held constant. The linearity of the RC time constant with respect to change in capacitance is illustrated in *fig. 16*.

Exponential Response

The behavior of the RC circuit with respect to an applied step function is plotted in *fig. 17*. This figure definitely shows that the response of the RC circuit is exponential. Many more measurements were taken on different days at different temperatures, with different values of resistance and capacitance; and under all above conditions, they definitely showed the transient response of pneumatic RC circuits to be truly exponential. Furthermore, the pneumatic variable mentioned above gave a very consistent performance under the same conditions. At the same time, the exponential data proved that the RC time constant is practically independent of the amplitude of the applied pressure.

The exponential behavior of the transient response of pneumatic variable resistors in series also was demonstrated by its linearity on semilogarithmic paper.

A Hopeful Conclusion

These experiments indicate that pneumatic RC circuits behave in a fairly linear fashion, under both transient and steady-state conditions, and thus indicate the usefulness of the analysis and charts presented.

Since the war, additional use has been made of the application of pneumatics in aircraft and, as evidence accumulates with respect to their behavior, safety and equipment-cost savings, it looks as though pneumatic systems undoubtedly will be used with increasing frequency in aviation.

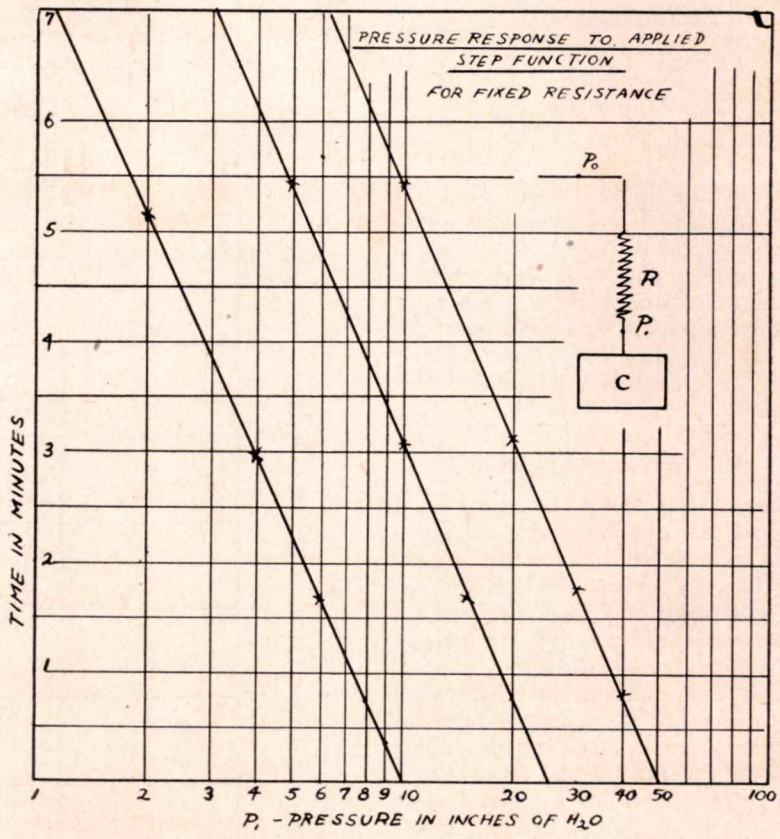


Figure 17

Michigan Musts

ALL LANDING facilities in Michigan, with the exception of emergency fields, have been licensed as airports, landing fields or approved fields.

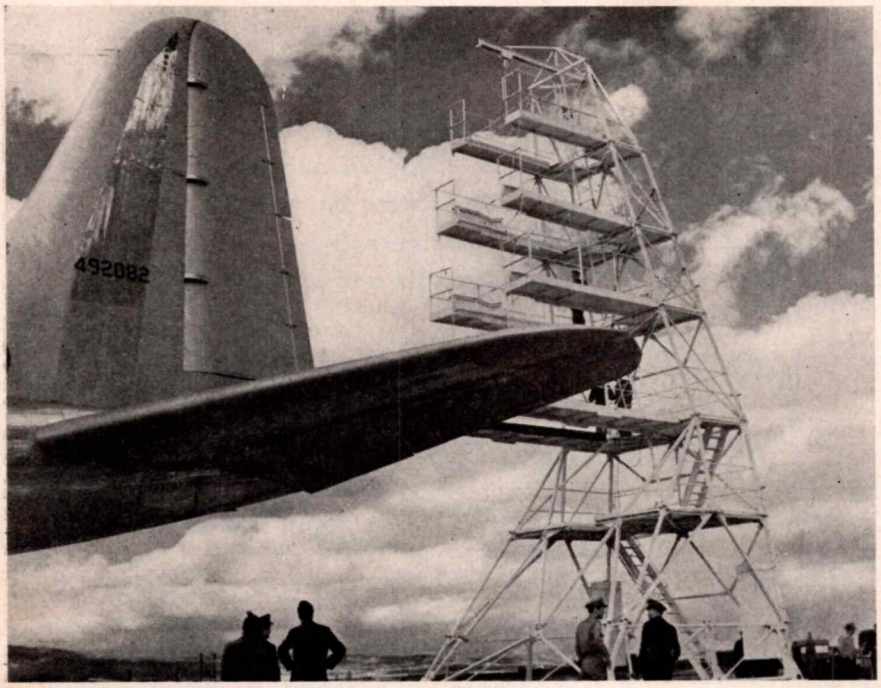
In addition to meeting minimum requirements of runway length and width, all licensed *landing fields* must have the following: suitable buildings, attendant from 8:00 A.M. to sunset during flyable weather, aircraft fuels, drinking water, toilet and tie-down facilities, first-aid kits and fire extinguishers.

A licensed *airport* must, in addition to the above requirements, provide a telephone, mechanical repair services on the airport and hangar facilities for transient aircraft.

An *approved field* must meet all the requirements for a licensed landing field, except that an attendant from 8:00 A.M. to sunset during flyable weather is not required.

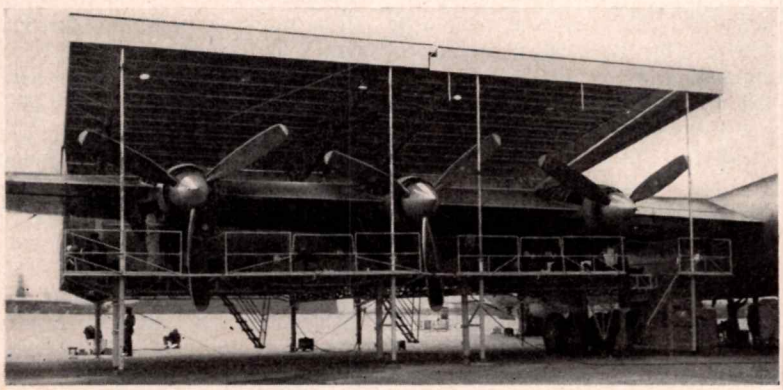
Emergency fields are not maintained and have no commercial operations, services or facilities available.

– MAINTENANCE TIPS –



Empennage Stand

CONVAIR B-36's at March AFB, Calif., are causing head-scratching among some maintenance engineers. Latest problem to be solved is how to service the 60-*ft* vertical stabilizer, rudder and tab on the huge craft. Jumbo Steel Products Co. of Azusa, Calif., has answered with a 60-*ft* stand having five U-shaped working platforms, each equipped with air, power and lights. The stand as a whole is constructed of special light-weight steel tubing, and is stressed to support a load of 100 *psf* on all platform areas. Decks are padded on the inside edge to protect the aircraft, and railings are supplied on all decks and ladders. The over-all weight is 17,500 *lbs*, including that of a winch on the top deck capable of lifting a 2000-*lb* load. The stand is mounted on 18-*in* diameter casters and is equipped with ballast tanks for use in high-wind areas. It can be disassembled and packed into crates for loading in a B-36 in two hours.

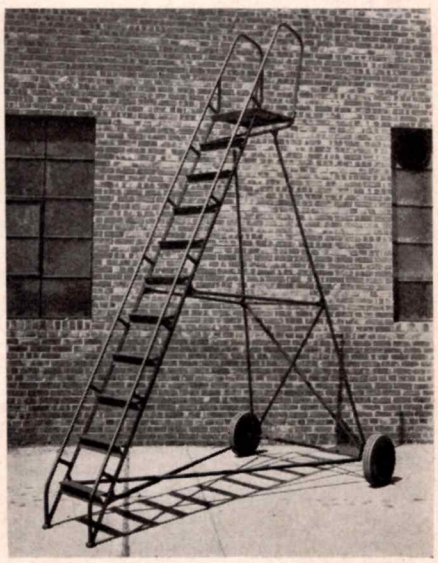


B-36 Service Docks

SINCE the Convair B-36 is too large to taxi into hangars for maintenance and service, the hangar must come to the B-36. Convair has solved this problem by building maintenance and service docks consisting of four sections, each 36 by 30 *ft*, enclosing 60 *ft* of a B-36 wing on each side of the fuselage. The docks are piped and wired for compressed air and electricity, and floodlights are built into the structure. Provisions are made also for mobile heating units for winter use. Two types of all-weather docks are planned for the future—a permanent ramp structure and a mobile dock to be moved from plane to plane, a time-saving advantage around large planes.

Instrument Lighting

RED instrument lighting will replace ultraviolet systems in Air Force and Navy planes following standardization of a Navy-developed red lighting fixture, according to the Department of Defense. Designed for attachment to the face of the instrument, and retained by instrument-mounting screws, the new fixture is said to provide more uniform illumination over the dial and reduce both initial and maintenance costs. Research by aero-medical psychologists had resulted in the discovery that red is the ideal color for cockpit lighting, since the "night-vision receivers" in the back of the eyeball are relatively insensitive to red light. This permits the pilot's eyes to adapt themselves to looking at the instrument panel and outside terrain without strain or timelag (AERO DIGEST, June 1949).



Maintenance Ladder

DESIGNED expressly for aircraft maintenance with provision for rapid folding, a new type maintenance ladder has been developed by Skyline Products, Inc. of Jamaica, L. I., N. Y. The new ladder is entirely of steel construction, with safety-plate step treads. It is available in any platform height with any-type wheel equipment.

P&W Engine Clinic

THE PRATT AND WHITNEY Aircraft Div., of United Aircraft Corp. also is bringing the factory classroom to the operator. Several months ago, they sponsored a clinic at Millville, N. J., attended by several hundred users of P&W engines, many of whom flew in.

Lectures were given on production methods and techniques, future development of aircraft engines, operation problems and the use of power calculators. An open forum devoted to maintenance problems, led by P&W Service technicians, ended the one-day session.

20TH CENTURY LIMITED

It is seen to be especially limited when one considers the short-sightedness of Navy Braid and Air Force Brass in their current squabble over which part of whose air power should do what. In reality, John Q. Public, who commands both, doesn't care a snap who does it as long as it's done economically and quickly

CY CALDWELL

IT IS ironically appropriate that the first half of the 20th Century should end with a public admission by the Air Force and the Navy that they cannot form a judgment of the merits or demerits of strategic bombing acceptable to both. At the half-century's end, this disagreement highlights the fact that the weapons of war have advanced faster than our thinking about them, and that the scientists and the engineers have out-distanced the military men—as usual.

In scientific, engineering and manufacturing progress, the first half of the 20th Century has whizzed by with the speed of a comet — Halley's not de Havilland's. Within a comparatively few years, man's ingenuity has given us the airplane, the tank, the aircraft carrier, the submarine, radio, radar, mass production, jet propulsion, automatic pilots—not only of aircraft but of supersonic rockets; air transport of everything from letters to tanks, army divisions and atomic bombs; proximity fuzes, air-to-air missiles, ground-to-air missiles—the list is endless.

We got hold of too much, too soon. A tiny minority, specialists in some particular field of human activity, have handed us a Pandora's box of new gadgets. And we simply don't understand them or know how to employ them to our advantage.

In research and invention, the 20th Century seems to be unlimited. The advances in knowledge have been enormous. But there does not seem to have been an equal advance in human intelligence. That is the limiting factor of the world. It is the factor that conceivably may lead our nation into a war that ends in defeat. Given two opposing national groups with equal, though diverse, war-making potentials, the group possessing the greater intelligence must win; the group with lesser intelligence must lose.

Both groups may have the same raw materials, the same mass weight of scientific, engineering and military brains; the same qualities of courage, endurance and determination. Yet there will be one factor that cannot be assessed in advance—the *collective guiding intelligence* of the opposing groups.

Germany had every ingredient but one necessary for waging successfuly a war of limited extent. What was lacking was a guiding intelligence capable of foreseeing how far to go, and by what means—of understanding that everything, including war, has definite limits. The controlling intelligence was Hitler's; and it was so limited that it scarcely deserves the term "intelligence." Rather, it was intuition, based on a wishful thinking—in short, madness, in a world of harsh reality.

What Is "Intelligence?"

Let us define intelligence, as distinct from knowledge. Intelligence is a term that is used with considerable latitude of meaning. Understanding is another name for it. Everyday usage tends to emphasize the practical character of intelligence as the ability to select and employ the right means in order to achieve the various ends pursued.

Example: an illiterate man, with no trade or profession—such as this writer—desires to cross a busy street. If he dashes into the traffic, hoping to dodge the onrushing vehicles, we would say that he displayed an obvious lack of understanding of the problem, that he was not intelligent. If, on the other hand, he watched the lights, waited for them to show red and stop the traffic, and then crossed, he would have displayed intelligence. This admittedly is a low order of intelligence; but each year many thousands of our citizens prove by their demise under automobile wheels that they did not possess the amount needed to get them across a street.

In understanding—a more intricate problem—the thought processes are basically identical with those of the man crossing the street. There must be a knowledge, an awareness, of the various factors involved, and *also* the ability to connect these factors in the mind, appraise them, and come to a decision. This intelligence is the ability, the mental function, of apprehending *connections*. These connections, as a rule, cannot be *per*ceived visually, but must be *con*ceived.

Example: In 1941, the High Command of the U. S. Navy perceived the battleship, the airplane carrier and the airplane. As all three vehicles were in and of the Navy, it is felt that certain officers in the Navy possessed exact knowledge of the war-waging abilities of these three differing weapons. Yet, as the war demonstrated conclusively, there was not within the Navy a controlling, guiding intelligence capable of apprehending the *connections* between battleships, airplane carriers and airplanes. If such an intelligence had guided the Navy, there would have been more carriers, more airplanes and fewer battleships. To have had all carriers and airplanes, and no battleships, would not have been intelligent.

The carrier and its planes were then untried in war; their potentialities were appraised, but unproven. The battleship was proved in war in those instances when it had come within range of an opposing warship. But a superior intelligence would have perceived that the carrier-airplane-bomb-torpedo combination outranged the battleship-gun combination. And that turned out to be the controlling factor in Pacific battles—as airmen inside the Navy and outside of it had perceived many year's before, beginning not only with Billy Mitchell but with many Naval airmen as well. We are doing today the same kind of poltical fiddling that we were doing immediately before Pearl Harbor. On the surface, world conditions are different; but fundamentally they are alike.

Russia is increasing its submarine and air fleets; we have decided not to build our 70-group Air Force, and we are putting more and more naval vessels, including carriers, into mothballs. We are cutting down our Armed Forces under the plea of economy; but we are not noticeably reducing the costs of civilian government—including subsidiaries to farmers (who vote) —the numerous over-lapping bureaucracies, the dictatorship of organized labor, and the high profits of Big Business—which suffers continuing defeats at the hands of labor and immediately passes the cost along to the consumer.

It is impossible to *prove* in advance of the next war that our top political and military planners are as unaware of scientific realities as were their counterparts of 1914 and 1939. The impression seems to prevail in political, military and ordinary civilian circles that, because we have made enormous strides in science and invention, we have become more intelligent. Surely we have more knowledge, more speed, more destructive power. But that is the result of intelligence on the scientific level—which always has been high.

Everybody's Stronger

True, we are stronger today than we ever were in advance of a war; but the enemy is stronger, too. Russia, bestriding the greater part of Asia and Europe, is geographically, politically, and economically stronger than Germany and Japan were together in 1939. With the help of German scientists and engineers, they probably are not far behind us in scientific advancements in weapons.

Politically, they seem to be ahead of us in that they have a plan of offense, while we cling to the defensive. Even our chief effort, the Berlin airlift, was essentially a gesture of appeasement. Thus, we evaded possible war—just as Mr. Chamberlin and his umbrella did at Munich. In the process, we learned a lot about mass air transport, which was our only actual gain for the expenditure of a quarter of a billion dollars. Like Chamberlain, we would do anything to cling to the illusion of peace for yet a little while longer.

That might have been sound policy if we had used the interim to grow stronger militarily. Actually, in relation to Russia, we have grown weaker in weapons—and the President urges that we grow weaker for blessed economy's sake!

We start the second half of the 20th Century as blissfully unaware of impending disasters as we were when we entered the first half, with this difference—everything has become more complicated, more expensive and very much harder to understand. Politically and militarily, I feel assured, we are *even less intelligent* than we were in 1900.

I know of no warning guide to future thinking other than a brief review of past thinking, all of it wrong. As you tick off these items, please bear in mind that the guiding political-military intelligence of the men who believed in these proved absurdities could have been no less than the intelligence of our leaders today.

They were the same kind of men, no better, no worse. They were politicians, with an eye on their job and on the electorate, and military men with ideas ingrained by decades spent in their professions. They were men in their fifties and sixties—and after forty most of us men tend to grow mentally musclebound. Such men as Winston Churchill, Bernard Baruch, Albert Einstein and Alben Barkley are exceptions. In the past, old men have planned war incompetently for young men to die in; our present old men seem to be planning that same kind of war for our sons.

That the Maginot Line was deemed to be almost impregnable and that the battleship was the best weapon for war at sea was so widely believed and so wrong that it need only be mentioned. Less well remembered is the fact that the invention of the machine gun, coupled with the use of age-old trenches, turned the victorious German march on Paris in 1914 into the war-of-position—that is, two powerful armies remained opposite each other for four bloody years with neither having the ability to break the other until the Allied armies became more numerous and powerful than the opposing German armies and the German economy at home faced utter collapse. The generals spent the war stuck in the mud, until superior forces—and the tank, invented by civilians—enabled them to reach a decision.

Civilian Victory

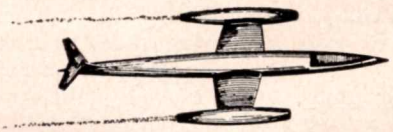
In short, that war was won by civilians; the armies themselves were 95% civilians inducted for war purposes. Yet the bizarre idea still persists that military leaders win wars!

You will recall how, in World War II, the German Army and Air Force, having been expended all over Europe and Africa, went down to eventual defeat when the *civilians* of Great Britain, the Empire and the U. S. built up enough of war's weapons and put enough of their sons into the armed forces to defeat Germany and Japan. Again, the civilians defeated the enemy, sometimes with the help of the generals, and sometimes in spite of them.

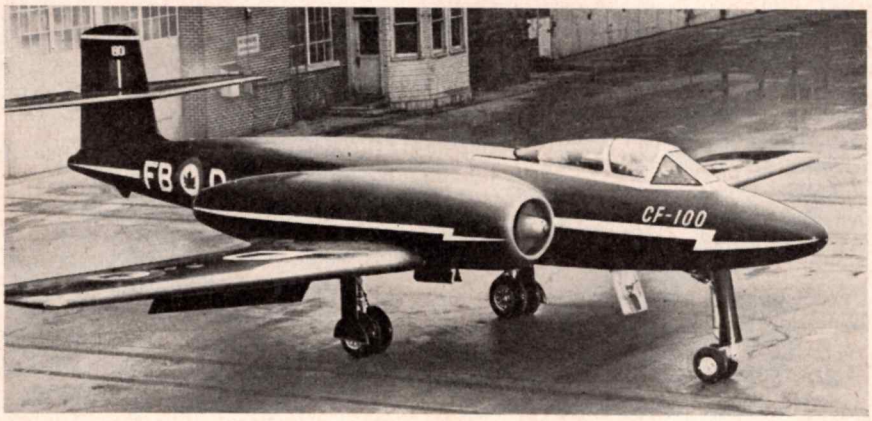
Do you recall the boasted ability of the Royal Navy and the U. S. Navy to destroy German submarines—without the use of escort carriers, none of which were in being until after the Germans had sunk millions of tons of Allied shipping? An American civilian suggested converting merchant-ship hulls into baby flattops. The admirals didn't even like the idea, or believe in it. Nor did our military experts believe when they found the Russian experiments with paratroops and gliders merely novel and amusing—until the Germans demonstrated their utility on Crete.

(Continued on page 88)

UNCLE SAM: *"I wonder if they remember Pearl Harbor!"*



REACTION-POWERED PLANES AND MISSILES



Avro CF-100 Fighter

AVRO CANADA has started taxi-tests on its CF-100 twin-jet fighter —the first front-line fighter to be designed in the Dominion. Built for the RCAF, it is said to be the initial long-range, all-weather aircraft of its type.

Power is supplied by two Rolls-Royce *Avon* turbojets mounted astride the wing on each side of the fuselage. These powerplants, developing approximately 6000 *lbs* of thrust apiece, almost hide the long, slim silhouette of the fuselage, although the *Avon* is small in diameter, considering its tremendous thrust.

The CF-100 carries a pilot and radio-navigator. It is 52½ *ft* long, has a wingspan of 52 *ft*, and its height from the top of the cabin to the ground is 10 *ft* 7 *in*. It is fitted with a dual-wheel, tricycle undercarriage, and will complement the RCAF's F-86 single-engine jet fighter.

CAA Certifies General Electric Jet

THE General Electric TG-190-B turbojet (USAF J47-GE-7) has been certificated by the CAA for commercial use—and the company states that it is ready to take orders for engines for commercial transports. It is the first axial-flow jet to be so approved in the U. S.; its military rating is 5200 *lbs* of thrust, and it is the most powerful in production in the nation.

General Electric officials believe that the first jet-powered transports will be propelled by engines now under development or in production, in light of the fact that military jet aircraft already have spanned continents and oceans in safety.

They believe that American-built jet transports may be in scheduled service by 1955—and emphasize that G E has the engines right now for safe operation.

Smog Control Through Better Combusion

DR. FRITZ ZWICKY, director of research for the Aerojet Engineering Corp., Azusa, Calif., and professor of astrophysics at the California Institute of Technology, suggests that a research institute should be created to coordinate scattered efforts in improving rocket and jet-engine fuels.

He believes that it is important to have propellants which react rapidly and in a well-controlled manner. Yet, the fuels must be safely inert in storage and in the fuel-feed system. A major problem is the transition from inertness to fast reaction.

Dr. Zwicky notes that many propellants generate smoky exhausts, in commercial as well as military applications. He feels that it is possible, theoretically, to make any fuel combination smokeless, even if solid exhaust products are produced.

His reasoning includes the possibility of eliminating industrial smoke.

Ceramic Contracts When Heated

A CERAMIC material, which apparently reverses generally accepted physical laws by contracting when heated and expanding when cooled, is supplied by the Stupakoff Ceramic and Manufacturing Co., Latrobe, Pa.

Basically a lithium alumino-silicate, it is said that the material can be formed and shaped by conventional methods and brought to precision tolerances by machining and grinding, where desired. Air Materiel Command engineers, who are evaluating the ceramic's use, believe that it has wide potentials in the building of jet-engine components and for radomes to house electronic instruments on guided missiles.

The material is said to be strong and able to withstand a thermal shock of at least 2000° *F*. It stood up well when formed into gas-turbine blades and is suitable for electrical and radio circuits.

Stupalith (the trade name) is a better conductor of heat than the normal ceramics, attaining temperature uniformity quickly. It can be prepared in various degrees of porosity to lighten its weight.

Shipboard Motion for Missile Testing

THE Naval Aircraft Factory, Philadelphia, has devised a testing platform which simulates the motion of a ship, to be used in studying the performance of small guided missiles which could be launched at sea. The device was built to assess the problems inherent in missile instruments because of the roll and pitch encountered by a vessel in open waters. It is also an example of economy, utilizing shore-stationed testing apparatus wherever possible.

"Kentanium" for Turbines

KENNAMETAL, INC., Latrobe, Pa., is building a 200-*hp* gas turbine as a research project to test critical

(Continued on page 68)

Long haul or short...

designed for profits!

Douglas Super DC-3

Only *economical* replacement for the famed DC-3—the new Douglas *Super-DC-3* offers unusual profit opportunities.

You can convert present DC-3s at a fraction of the cost of new transports—and get planes that are fast, modern, familiar and economical to operate.

The *Super DC-3* carries up to 31 passengers at 250 mph. Payload is almost *double* that of the DC-3, and gross weight is 5,800 pounds greater! Built-in steps lower for use in a matter of seconds. Passengers carry wraps and luggage on and off to reduce ground delay.

Large rear cargo space with upswing door makes possible combined cargo-passenger operations. Thus the Super DC-3 provides economical transportation with maximum convenience and efficiency.

DOUGLAS AIRCRAFT COMPANY, INC., SANTA MONICA, CALIFORNIA

DEPEND ON DOUGLAS

30TH ANNIVERSARY YEAR

TURBOJET COMBUSTION-CHAMBER PROBLEMS*

DR. STEWART WAY

Manager, Thermodynamics Section, Westinghouse Research Laboratories

THE rise to prominence of the turbojet engine in the aircraft-propulsion field was based in large part on the development of combustion chambers that would liberate heat in an airstream at an extraordinarily high rate. Not only was it necessary to liberate several thousand *Btu/sec* per *sq ft* of cross section, per atmosphere of pressure, but also to do this in a passage of a length of the same order as the diameter of the engine, or even shorter.

More specifically, the average velocities that would exist in the stream of air from the compressor—were this stream uniformly to fill the cross-section within which the combustion chamber is to be located—are as high as 90 *fps*. In contrast with this figure, the mixture velocity at the mouth of a conventional Bunsen burner is only of the order of 5 *fps* to 10 *fps*.

For a successful turbojet combustor, local slowing down of the stream is necessary to provide a steady ignition zone, and marked turbulence has to be introduced to aid mixing of burning with unburned gases, thus speeding the burning process. It is apparent that compact burning may be realized in this manner, except for one troublesome factor — the total pressure-drop across the burner must be kept to a low value of not more than 4% or 5% of the burner-inlet total pressure.

Another complicating factor in gas-turbine combustion chambers is the fact that present-day materials require a peak turbine-inlet temperature of not over about 1550°*F*. This leads, to air: fuel ratios of 40 or 60 to 1, or greater, for lower turbine inlet temperatures *(fig. 1)*. Since the burning process is known to be most satisfactory with air-fuel ratios in the range 20-30, it is apparent that considerable quantities of excess, or secondary, air must be mixed into the hot gas stream to lower its temperature to the values required by the turbine; and this mixing must be done in time to provide an acceptable temperature distribution at the turbine inlet. This mixing, also, must be accomplished in the short distance from fuel nozzles to turbine blades. Furthermore, pressure drops associated with mixing process again must be kept within the desired limitations.

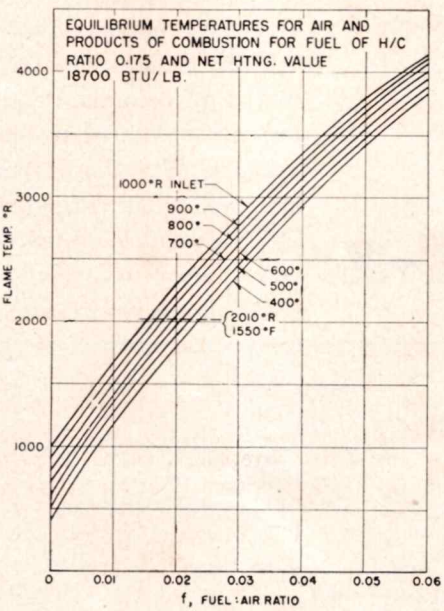


Figure 1

The problems of securing wide operating range and good combustion efficiency are so closely related that they must be dealt with together.

Assume for this discussion that the size of combustion-chamber space, both as to cross-section and length, has been fixed, and that it is desired to arrive at a combustion chamber which will be capable of operation over a wide range of inlet-flow variables, and of attaining the maximum rate of energy input to the airstream. It is desired also to carry out the combustion with maximum efficiency at all conditions.

To help form some idea of the range of operating conditions that one might be expected to cover with a turbojet combustor, a tabulation is given in *Table I of* typical values of mean flow velocity in the combustor section, burner-inlet temperatures and pressure, and required temperature rise for steady running of the engine. As an independent parameter, we give the engine *rpm* in percent. Ground starts would require a still lower operating speed than the 25% figures given.

It may be noted that, if we compare the relative fuel rates at sea level, 100% speed, 500 *mph* and at 50,000 *ft*, 25% speed, zero ram, we find a range of fuel rates to be covered of 69:1.

If, now, a given burner, operating with given inlet-flow conditions, has the fuel rate gradually increased, one may observe an increase of burner-temperature rise of ΔT as indicated in *fig. 2*. This temperature rise may increase, go through a maximum and then decrease to the blowout point as in *(a)* or increase steadily to the blowout point as in *(b)*.

The importance of burning over a wide operating range is sharply emphasized by the observation that failure of the burner to produce the ΔT required for steady running of the engine, at some particular engine speed and altitude, results in the engine becoming inoperative at that condition. In this way, most engines exhibit "altitude operational limits."

Another type of operational limit occurs as the fuel-air ratio is reduced. Eventually, a lean limit blow out point

TABLE I

COMBUSTOR OPERATING VARIABLES—TYPICAL TURBOJET ENGINE

Flight Speed *mph*	Altitude *ft*	% *rpm*	Inlet Press. p_{1t} *(psia)*	Inlet Temp. T_{1t} (°R)	Inlet Velocity *u (ft/sec)*	Temp. Rise ΔT (°R)
0	0	25	16.6	542	37.3	988
0	0	50	23.0	605	69.0	800
0	0	75	38.0	705	88.7	755
0	0	100	61.8	836	92.0	1104
0	30000	25	5.1	434	37.1	759
0	30000	50	7.6	497	66.5	613
0	30000	75	13.6	595	81.0	646
0	30000	100	22.1	724	83.0	1126
0	50000	25	1.98	415	37.2	719
0	50000	50	3.00	476	66.1	584
0	50000	75	5.51	574	78.6	638
0	50000	100	8.85	702	81.2	1128
500	0	75	45.5	750	91.0	813
500	0	100	73.5	882	95.3	1098

* Condensed from a paper presented before the Institute of Aeronautical Sciences in Cleveland during March, 1949.

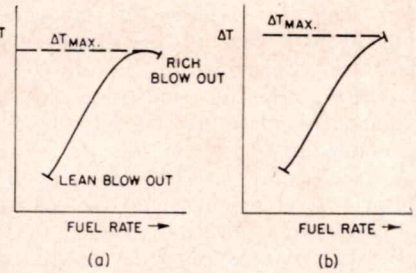


Figure 2

is reached. What is of greater importance than lean limit blowout in most instances, is the limitation arising from the low fuel rate itself; this may lead to either extremely poor combustion efficiency or very bad temperature distribution. Both troubles are associated with low fuel pressure and poor atomization at the very low fuel rates. In general, it is more important to have high efficiencies at the higher *rpm's* than at the lower *rpm's*.

A turbojet combustor may be one of a great number of types. In all of them, however, if good performance is to be realized, certain basic principles must be observed. Two of these are, *(a)* the creation of an ignition or piloting zone where velocities are fairly low, a combustible mixture is present of proportions suitable for burning and a means of igniting the mixture is always at hand; *(b)* a reaction zone in which the burning process may be carried to completion and in which as high a degree of turbulent mixing is produced as is consistent with burner-pressure drop limitations.

Consider a combustor of the form shown in *fig. 3*. This sketch represents a typical single-cell burner, of a type which could be used in multiple for heating large quantities of air from the compressor. The same features would be adaptable to annular-type combustion chambers. This burner is typified by sidewall cooling slots, holes for lateral air admission and fuel injection by an atomizing nozzle at the upstream end.

The ignition zone is the region within the dome and immediately downstream from it. Experiments show that, with loss of ignition in this zone, the burner becomes inoperative and either blows out or is very near to the point of blowing out. Operational experiments have shown that the reaching of a maximum-attainable temperature rise —because either of blowout or sharply decreasing efficiency with increasing fuel rate—is the basic cause of the engine operational limit. Both the limiting temperature rise and the blowout are seen to be associated closely with loss of ignition in the upstream end of the burner.

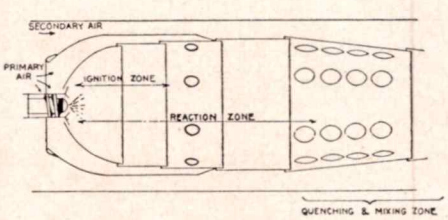
In the burner of *fig. 3*, the reaction zone, while consisting in part of the afore-mentioned ignition zone, extends further downstream. Tubulent mixing in this zone is promoted by the lateral entry of air through holes in the flame tube. The total length of the zone in which reaction is taking place will depend upon the rate at which fuel is being supplied to the burner, and will range from one to five flame-tube diameters. Flame of several times this length is obtained when lateral air admission is not utilized.

In order to observe in greater detail what is going on within a slotted flame-tube burner with lateral air admission, a *Pyrex* flame tube was constructed. On this transparent burner model, observations were made of the flow patterns with and without burning. These were qualitative observations only, but they disclose much that is of interest. *Fig. 4 (a), (b)* shows flow-pattern sketches made from direct observation with a tufted wire; *fig. 4 (c)* shows the type of flow observed after the start of burning.

In the latter case, methyl alcohol was used for fuel to give a non-luminous flame, and a wire probe, the end impregnated with sodium chloride, was used to indicate flow direction. A yellow plume of flame projects from the end of the wire. During burning, a pronounced assymmetry of the flow pattern was observed under some conditions which, however, could be reduced by restricting the air flow through the slot behind the fuel-nozzle baffle.

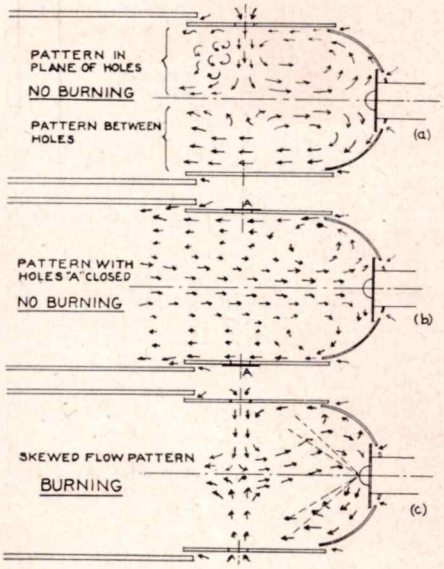
The Reversed Flow

It is quite obvious that there is a strong reversed flow commencing about where the radially-entering jets merge in a high-pressure area. The velocity of this stream was found to be about 6% of the lateral jet velocity. This reverse flow serves to provide air to the ignition zone, to carry hot flame gases back, thus insuring continuous ignition, and to preheat the rearwardly-flowing air stream. The flow through the slots in the flame tube and around the dome augments this reverse flow in the center of the burner by virtue of its action as the driving jet of an annular



TYPICAL SINGLE CELL BURNER

Figure 3



FLOW PATTERNS IN PYREX BURNER

Figure 4

jet ejector. The main driving force, however, for the creation of the reverse flow, comes from the impinging radial jets, for, when they are cut off, the flow becomes at once much slower and calmer.

Burners of the type which mix the fuel with the air in the reaction zone, may exhibit rich-limit burning characteristics as shown in *fig. 5*. The curves were obtained from tests of a 4-*in* diameter flame-tube burner with hemispherical dome, operating at several pressure levels. The fuel used boils in the range 95°*F* to 590°*F* with 50% point at 331°*F*. The net heating value is approximately 18,500 *Btu/lb*. The curves in *fig. 5 (a)* show the velocity in the primary zone (reaction zone) of the burner, computed for inlet flow *vs* effective air-fuel ratio at the condition of maximum temperature rise. The effective air-fuel ratio is the ratio of primary air to the product of fuel rate and combustion efficiency. Also shown are isolated points for *actual* primary air-fuel ratio; these points have somewhat more scatter than those for effective air-fuel ratio. Only the ΔT_{max} points are shown; rich blowout points were often at somewhat higher fuel rates.

Lean blowout points also were measured in these studies, but show considerable scatter, owing to the presence of the very light fractions in the fuel used, which tended to vaporize at the low fuel pressures corresponding with the low fuel rates. The lean blowout limits tended to follow the pattern of being determined mainly by the magnitude of the fuel pressure, difficulties with burning being encountered at pressures below 8*psia*.

In *fig. 5 (b)* a cross plot of the data

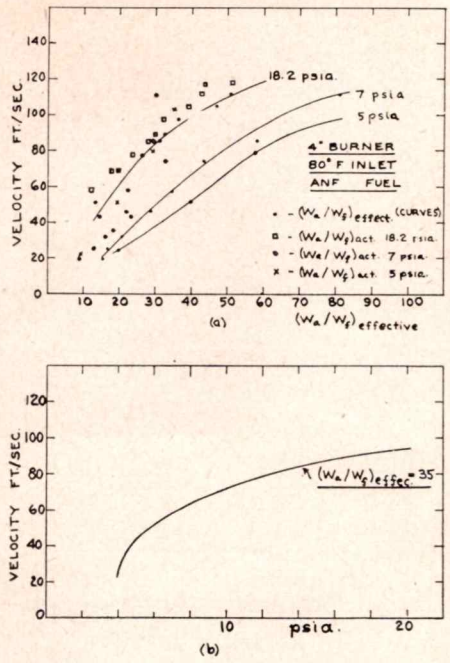


Figure 5

from *5 (a)* shows the behavior of primary air velocity *vs.* burner pressure for a fixed effective primary air: fuel ratio of 35. The above experiments were all conducted at 80°*F* inlet.

Heat-Liberation Rate

It will be noted that the maximum heat-liberation rate at any one of the pressures investigated does not change appreciably with change of air-fuel ratio. This is indicated by the nearly constant value of the ratio of ordinate to abscissa. The combustion efficiency at the condition of ΔT_{max} likewise, does not vary appreciably with air-fuel ratio except for some indication of a preference for effective air-fuel ratios in the range 20-35. On the other hand, there is a significant variation of combustion efficiency with pressure in the combustor, when operating at ΔT_{max} conditions. Taking the averages of the tests, we obtain the following

18.2 *psia*	89%
7.0 *psia*	65.3%
5.0 *psia*	43.9%

It is quite likely that the main cause of this falling off of efficiency with combustor pressure is due to the direct loss of unburned fuel on account of liquid impingement on the walls, which is more pronounced at low densities in the burner. Another factor is the gradual approach to conditions of narrowed inflammability limits and, eventually, impossibility of burning as the pressure of a fuel-air mixture is reduced.

If we look at the operation of the burner at conditions other than those for ΔT_{max} or blowout, we find that there is an optimum primary air-fuel ratio for best combustion efficiencies. The actual primary air-fuel ratio is found to be in the range 18-30 if we want best efficiencies.

In *fig. 5 (b)* it is significant also to note that, with decreasing pressure, the limiting primary air velocity (for ΔT_{max}) falls off, gradually at first and then more sharply. Curves similar to this could be plotted for other effective primary air-fuel ratios. If there was no falling off of this velocity, we might conclude that the attainable heat release in a burner (of this type) was given by a critical value of *Btu* per *sq ft* per *sec* per atmosphere of pressure. Since the velocity does fall off with decreasing pressure, the *Btu/ft² sec atm* must decrease with decreasing pressures.

Looking at the problems of range and efficiency in more general terms, we may call attention to certain other aspects of the combustion chamber.

The lean blowout limits, insofar as they are not caused by inadequacies of the fuel-injection system, often may be improved by restricting the amount of air entering the ignition zone through the end dome. There are quite wide variations from point to point in the reaction zone, in fuel concentration. This ranges all the way from practically pure fuel vapor around the fuel droplets to pure air near the primary air openings. We also have various concentrations of the product gases intermixed with the fuel-air mixtures. It is probably highly desirable from the standpoint of compact burning and stable ignition, to have this non-uniformity of mixtures.

With a uniformly pre-mixed combustible, the range of mixtures that can be accommodated is not nearly as wide as in the turbojet-type combustor which accomplishes mixing right in the reaction zone. Whereas the range of primary air-fuel ratios that can be covered with a turbojet-type burner is roughly 8:1 up to 100:1, this range for a flame holder operating in a stream of pre-mixed combustible is considerably lower.

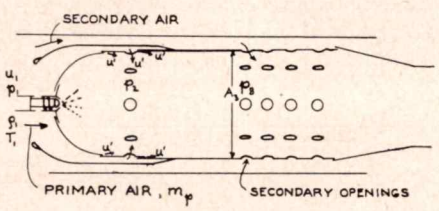


Figure 6

Since there is something to be gained by operating the burner with primary air-fuel ratios in the range 20 to 30, it may be expected that future developments will see greater attention to realization of such favorable proportions over the entire operating range.

Another Method

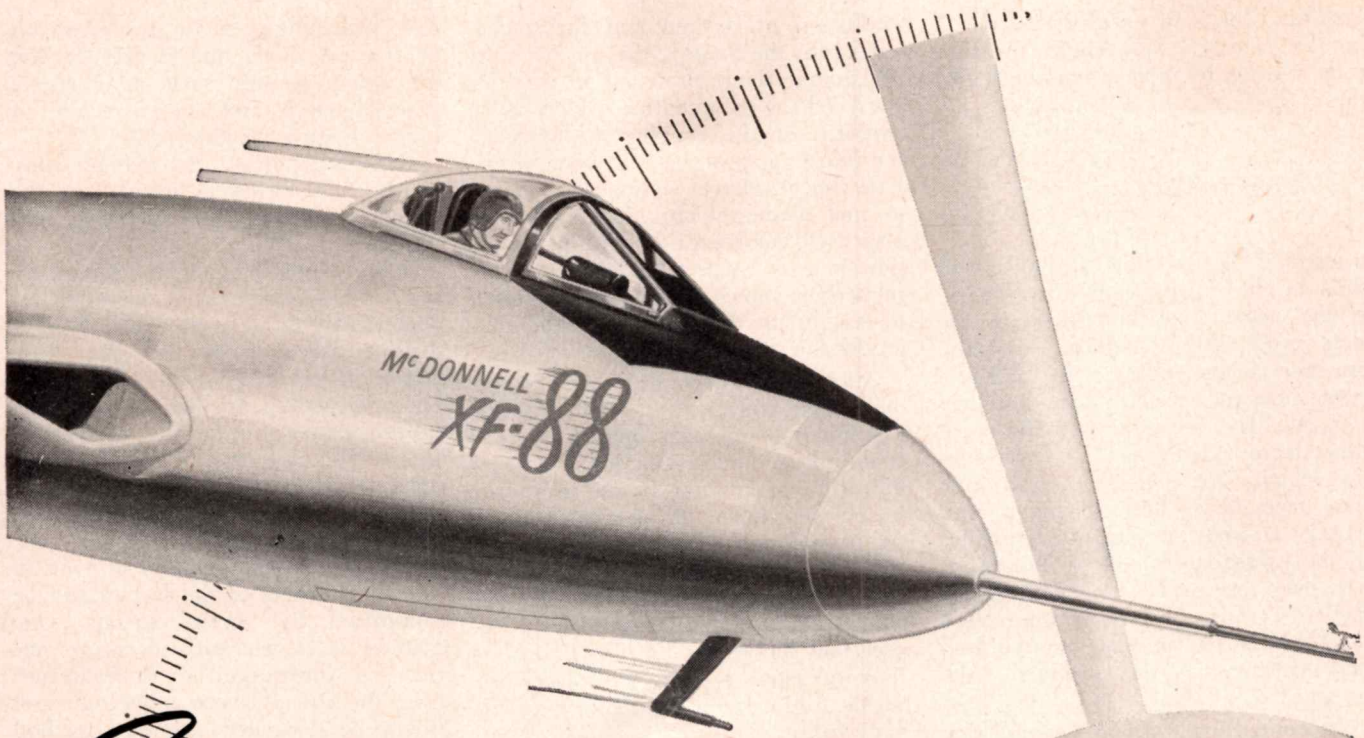
Another line of attack — if one wishes to increase the output of a combustor—is to introduce additional fuel and air in the downstream part of the reaction zone without altering basically the combustion process going on in the ignition zone. In this way, the blowout limit can be extended to higher fuel and air rates. The limitation eventually would be the flame length, in this case, or falling-off of efficiency by premature quenching of the reacting gases by the secondary air.

As regards the choice of burner dimensions, experience indicates that burners of the step-wall, lateral-air admission type, operating at standard atmospheric pressure and temperature, and presently accepted pressure drops, can liberate about 4500 *Btu/sq ft sec* and not much more. A safe figure for design would be somewhat lower. If one assumes 3000 *Btu/sq ft sec* as a reasonable figure, one would find, for example, that to burn 200 *lbs* per hour at atmospheric pressure, the burner cross-sectional area should be

$$A = \frac{200 \times 19000}{3600 \times 3000} = 0.352 \text{ ft}^2$$

The flame-tube wall-pressure drop might reasonably be taken as 3% of the inlet pressure, for an inlet pressure of 14.7 *psia*, or 0.441 *psi*, or 63.6 *psf*. The velocity of the radial air jets entering the burner would then be 234 *ft/sec*, and, if the primary (combustion) air is to be 20 times the fuel rate, (or 4000 *lbs/hr*) the area of openings in the ignition and reaction zone can be calculated. It is necessary only to introduce proper orifice coefficients.

The design of the flow-path for the secondary stream of cooling air *(fig. 6)* is one that must be based upon considerations of pressure drop. If one assumes, for example, that the pressure in the upstream part of the burner is 0.97 p_{1t}, where p_{1t} is burner-inlet total pressure, then the static pressure p_3 at the point where secondary air is mixed will be 0.97 p_{1t}—Δp_{23} where Δp_{23} is the static-



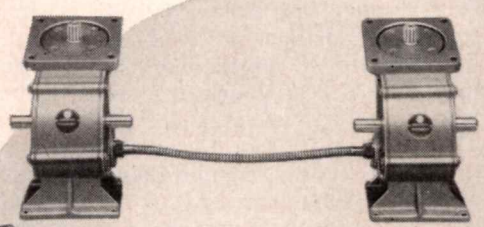
Split second performance requires hair-trigger operation!

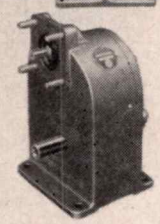
As the speeds of aircraft have gone up and up and up . . . as the complexities of aircraft have thrown additional burdens upon the pilot, the need for mechanical control has become more essential. Many of the nation's manufacturers of aircraft have called on Foote Bros. to produce units such as landing gear actuators, speed brake actuators, jet engine accessory drives and rotor drives.

These units must meet extremely rigid specifications. They are required to fit a confined space envelope. High speeds call for the utmost in precision. Minimum weight is of greatest importance.

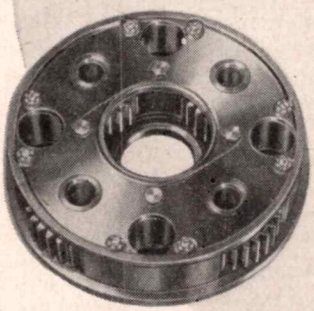
Foote Bros. aircraft devices and Foote Bros. precision gears are engineered and produced to meet these exacting specifications and are serving on such famous aircraft as the McDonnell XF-88 and Banshee, the Boeing B-50 and B-47, the Piasecki Helicopter, the Convair B-36, the Lockheed Constellation and many others.

FOOTE BROS. GEAR AND MACHINE CORPORATION
Dept. B, 4545 South Western Boulevard • Chicago 9, Illinois

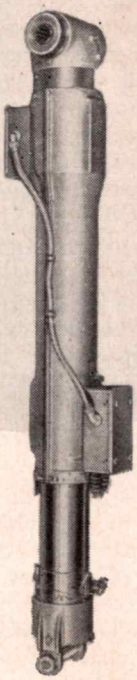




Speed brake system engineered and produced by Foote Bros. for the McDonnell XF-88



Main rotor drive built by Foote Bros. for the Piasecki Helicopter.



Landing gear actuators on the Boeing B-47, B-50 and C-97—a product of Foote Bros.

FOOTE BROS.

Better Power Transmission Through Better Gears

pressure drop between stations 2 and 3 in the burner. This static pressure drop will be, by momentum considerations

$$\Delta p_{23} = 2q_p \cdot \frac{\rho_1}{\rho_3} - \frac{m'u'}{A_3}$$

where m' is the flow through wall slots in the downstream direction, u' is the velocity of flow through the slots, and q_p is the (fictitious) dynamic pressure corresponding with total primary flow at density ρ_1 in cross-section A_3. The secondary stream must flow from condition *(1)* (pressure p_1, velocity u_1, density ρ_1), through the secondary flow channel and emerge at back pressure p_3. Estimates of the pressure drop along this channel may be made by conventional methods. The channel cross-section must be chosen so that the required flow emerges at the specified back pressure p_3.

In connection with the combustion efficiency at very low and very high fuel rates, the characteristics of the fuel injector are of considerable importance. It has been found that excessively high fuel pressures are undesirable, not only from the standpoint of fuel supply complications, but also as regards burning. An excessive fuel pressure propels too many droplets against the burner walls, along which the liquid runs. This leads to inefficient burning of the fuel. At very low fuel rates, on the other hand, the spray cone from a fixed-orifice nozzle collapses and poor atomization is the result. Atomization under these conditions may be improved by recourse to more complicated variable-orifice nozzles, dual-flow nozzles, return-flow nozzles air atomization or one of several simpler expedients. Among these may be mentioned the modification described in NACA-T.N.-1618.

The use of vaporizing types of fuel-injection systems, such as have been pioneered by Armstrong-Siddeley, Ltd., should be mentioned also as a promising approach to the problem of improving combustion efficiency at conditions of low fuel flow, where conventional atomizers would lead to difficulties.

Basic work on flame propagation and flame quenching is of importance here in that the results of such studies are needed as we attempt to verify hypotheses concerning the factors affecting flame stability.

Although the burning that takes place in the turbojet combustor is of a highly turbulent character, and occurs in large part as diffusion burning (diffusion of oxygen and fuel molecules into the flame), the normal rate of laminar flame propagation may be regarded as a quantity which is a measure of the rapidity with which the burning process can take place: Experiments have shown that hgih, normal flame-velocity fuels lead to improved combustor operating velocities. It may be possible, therefore, to relate flow velocities to flame velocities in setting up dimensionless equations describing burner performance.

Another quantity of interest is the quenching distance, or the distance a laminar flame can approach to a cool wall without extinction. The stabilization of laminar flames is known to be dependent on the relation of the quenching distance to the distance from the wall out to points where the flow velocity is comparable with the flame velocity; there is reason to expect that flame stabilization in turbojet combustors may be influenced also by the ratio of quenching distance to scale factor.

In this connection it may be of interest to mention a conclusion from dimensional analysis, which does not apply to turbojet burners directly since it assumes a premixed combustible gas, but which indicates the sort of results that are obtained for burning processes via dimensional analyses:

$$\frac{u_{cr}}{v} = F\left(f, \frac{D}{d}, \frac{vd\rho}{\mu}, \frac{T}{T_o}\right)$$

where

u_{cr} = blowout velocity for flame holder
v = normal flame velocity
f = fuel: air ratio
D = scale factor
d = quenching distance
ρ = inlet density
μ = inlet viscosity
T = inlet temperature
T_o = reference temperature

The accumulation of deposits of carbonaceous material in the combustor is objectionable because it may endanger the turbine blades if pieces break loose, because it may burn, causing local high wall temperatures, and because it may interfere with fuel or air distribution.

It is a well-known fact that certain fuels are more prone to contribute to carbon deposits than others. The constituents that tend to give solid carbon are chiefly the aromatic hydrocarbons and the residual and high boiling-point constituents. The newer, "high availability," jet fuels are more difficult to burn cleanly than the older paraffinic fuels, both on account of the higher aromatic content (hydrocarbons of cyclic structure with alternating single and double carbon to carbon bonds, such as benzene, toluene, etc.) and the presence of higher boiling fractions.

Carbon deposition depends not only on the fuel, however, but also on the burner design and the operating conditions.

Solid-carbon accumulations may result from several causes, operating independently or in unison. One type of deposit arises from the quenching action of relatively cool surfaces on luminous flames. Carbon deposits due to this cause are usually of a light sooty structure. Another type of solid incrustation is due to the presence of liquid fuel which is boiled away from the flame-tube walls.

The actual accumulation of soot on interior surfaces of the burner can be minimized by several means. One method is to use surfaces of porous material which admit air to the burner over the areas where otherwise soot might be deposited. Another method is simply to design the surfaces to operate at higher temperature; the solid carbon can then be burned away as fast as it forms. This method has the obvious structural disadvantages associated with high wall temperatures. One other method of preventing soot deposits is to sweep the internal surfaces tangentially with incoming films of air, thus blowing off any solid particles that otherwise might become lodged. Still another method of minimizing deposits of the sooty type is to alter the gross aspects of the flow path in the burner so that flame gases are blown away from the surfaces prone to soot accumulation. Thus, soot deposits on the end plate around the fuel nozzle may be minimized by inducing a downstream flow away from the fuel nozzle. This may, however, have adverse effects on flame stability.

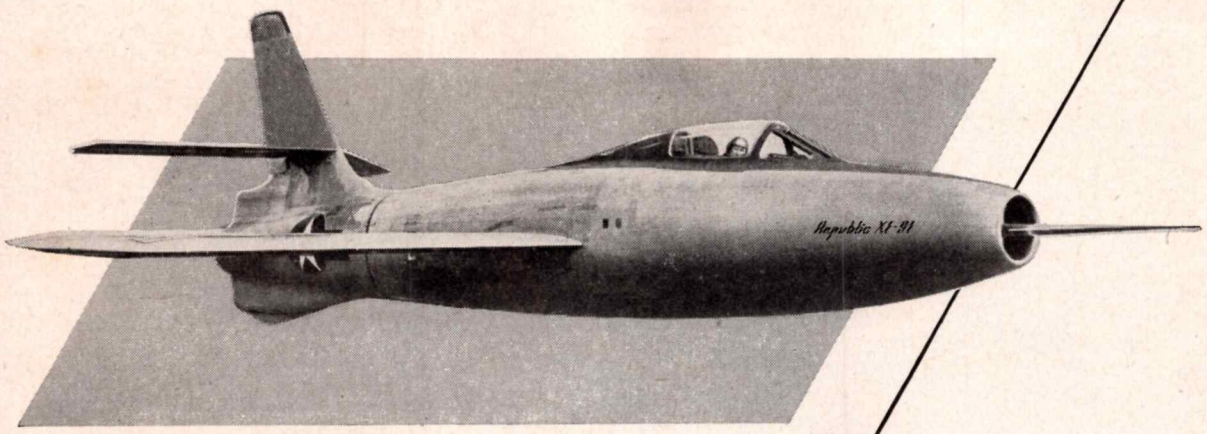
Wall Effects

It may be observed, in burners, that, as the fuel strikes the wall, it either may run along the wall, vaporizing as it goes while keeping the wall continually wet; it may vaporize from the wall at hotter regions where everything is boiled away except the residues, leaving a tarry deposit; or droplets may impinge on still-hotter wall surfaces and quickly slide or bounce off without wetting or discoloring it in any way since they have been cushioned by a layer of fuel vapor.

Observations made with the *Pyrex* burner model clearly demonstrate the occurrence of wall wetting of relatively cool walls by the liquid fuel without discoloration, and almost complete

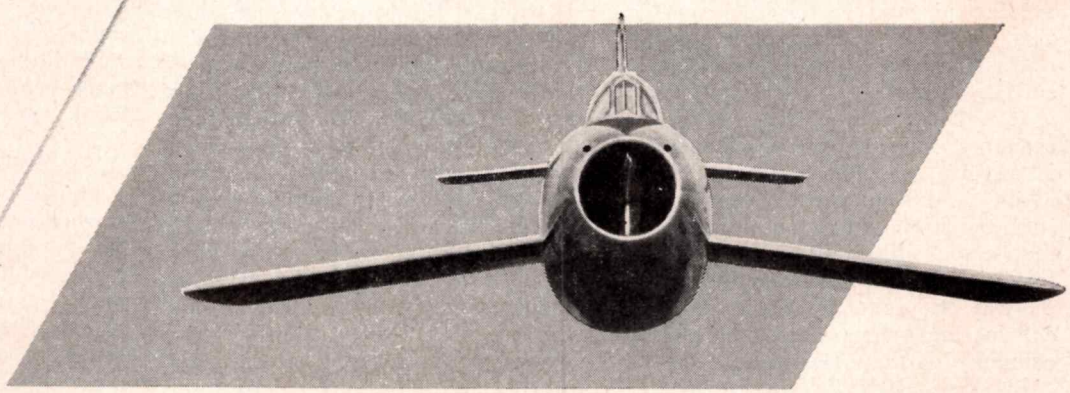
(Continued on page 87)

THIS IS THE XF-91



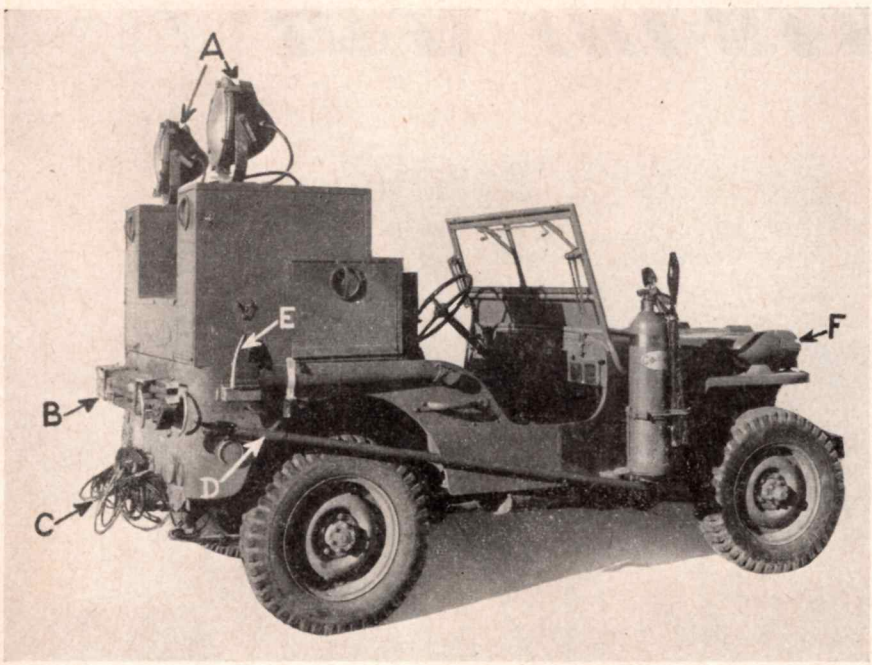
Made by the makers of the mighty Thunderbolt . . . which set enviable records in the hands of Air Force pilots during World War Two . . . and later, builders of the F-84E Thunderjet now being manufactured in quantity for the Air Force . . . Republic is justifiably proud of the XF-91 presently undergoing flight tests at the Muroc Air Force Base in California. ¶ *Conceived and produced to perform as a high speed . . . high altitude interceptor . . . with both turbo jet and rocket power . . . the final acceptance specifications of this great ship will, we are confident, prove to be one more vital weapon in Democracy's arsenal.*

. . . Republic Aviation Corporation, Farmingdale, Long Island, New York



REPUBLIC AVIATION

Makers of the Mighty Thunderbolt · Thunderjet · XR-12 · XF-91



Fire-fighting and crash-rescue "jeep" developed by the USAF Air Materiel Command several years ago to provide a relatively low-cost, effective unit which is sufficiently agile and powerful to meet all but the most serious conditions. Can be manned and put into prompt operation by personnel in regular airport activities. (A) floodlights; (B) folding ladder; (C) steel cable with grappling hook; (D) pike pole; (E) fire axe; (F) siren

Fire Fighting and Crash Rescue at Small Airports

JEROME LEDERER
Director, Flight Safety Foundation, Inc.

IN OUR Western civilization, we believe in the dignity and preservation of the individual. This must be fundamental to all activities, if we are to maintain our way of life. But fire fighting and crash rescue, which are instrumental to this end, can be very expensive, and economic survival overshadows all other problems at smaller airports.

It is felt, however, that, within his economic capacity, the small operator is anxious to fulfill a moral responsibility to his mankind. Therefore, I shall try to show how one might meet that responsibility at minimum cost for the small airport—and the quickest way to prove the effectiveness of current equipment is to cite specific examples of their successful use.

In May, 1947, a non-scheduled DC-3 overshot Newark Airport. The right engine burst into flame when the airplane struck the bank of a creek. The passengers, momentarily dazed by the impact, remained in their seats. The pilot and co-pilot were trapped in the cockpit by collapse of structural members. The fire, feeding on oil, hydraulic fluid and gasoline, was traveling into the wing.

The control tower had observed the poor landing approach and promptly alerted the crash crew. They responded with a Cardo truck and three smaller units and arrived within a few seconds after the plane stopped rolling. A discharge of 1600 *lbs* of carbon dioxide and 150 gals of foam from the same piece of equipment snuffed out the fire within 2½ minutes and, within 1½ additional minutes, the firemen, using hacksaws and crowbars, freed the crew while others led the passengers to safety through regular passenger exits. The prompt presence of a trained crew in this instance certainly saved the crew and probably 10 other lives. However, that was a case of adequate equipment plus trained organization.

In 1943, two young mechanics finished working on a DC-3 at La Guardia Airport and, being in an irresponsible mood, decided to fly it. One had soloed an Aeronca and so, with the sublime over-confidence of youth, they took off. After some erratic flying and one pass at a landing, they circled the field again, narrowly missing a building, and crash-landed. The two mechanics survived the crash, but were trapped by leg injuries.

A small fire started in the left engine. A number of spectators were standing by; the police car was bogged down on soft earth. Spectators could have rushed to their rescue had they known what to do. The men might have been saved, but, unlike the first accident there was no organized attempt to do so. (Incidentally if you are piloting a plane and are about to crash, pull up your legs, because it's usually the legs that trap you in there.)

This is the result of inadequate crash-rescue organization and equipment.

In August, 1948, a plane with three persons aboard crash-landed in New Jersey. The occupants were pinned in the wreckage, which caught fire. A vacationing fireman organized six spectators into a bucket brigade and directed a stream of water from a garden hose which was available. These efforts were sufficient to check the flame while the three survivors were rescued and carried to a safe location.

At every airport, there are employees who have an irresistible desire to rescue others who are about to perish. They do it not because they want to be heroes but from a genuine desire to save life. If this is so, why not help them do the job with the least danger to themselves and with greater efficiency by giving them proper training and as many of the essential tools as you can afford. The most effective equipment for the rescue of occupants of crash aircraft is well-trained manpower, even if it is only one man. But an efficient man cannot function without tools. With very little cost, these tools can be made available. Many are already at hand, used in day-to-day activities.

Man With a Cool Head

Consider the case of a DC-3 that crashed one night in 1941 just outside the St. Louis Airport. It struck a high-tension line. The gasoline tanks were leaking; survivors were lying about. The highly charged cable was slithering over the wreckage producing great sparks. An airline mechanic recognized the danger, seized an axe and cut the cable in two, thus preventing a probable catastrophe. The axe is a simple tool; in this case it was at hand and was 100% effective. The mechanic happened to have enough

(Continued on page 97)

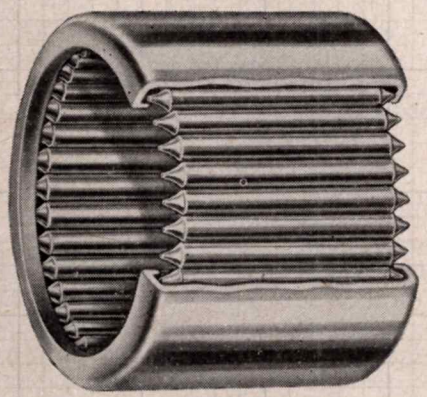
TORRINGTON NEEDLE BEARINGS

give maximum load distribution

Torrington Needle Bearings distribute radial loads over a greater bearing area than any other type of anti-friction bearing of comparable size.

This unique engineering feature of Torrington Needle Bearings assures maximum load capacity for any given housing or shaft size.

Where you encounter high load conditions with fixed or rigid space limitations, you will find the Torrington Needle Bearing specially engineered to give you this and other important advantages. Why not discuss your problem with our engineers? They'll be glad to help you.



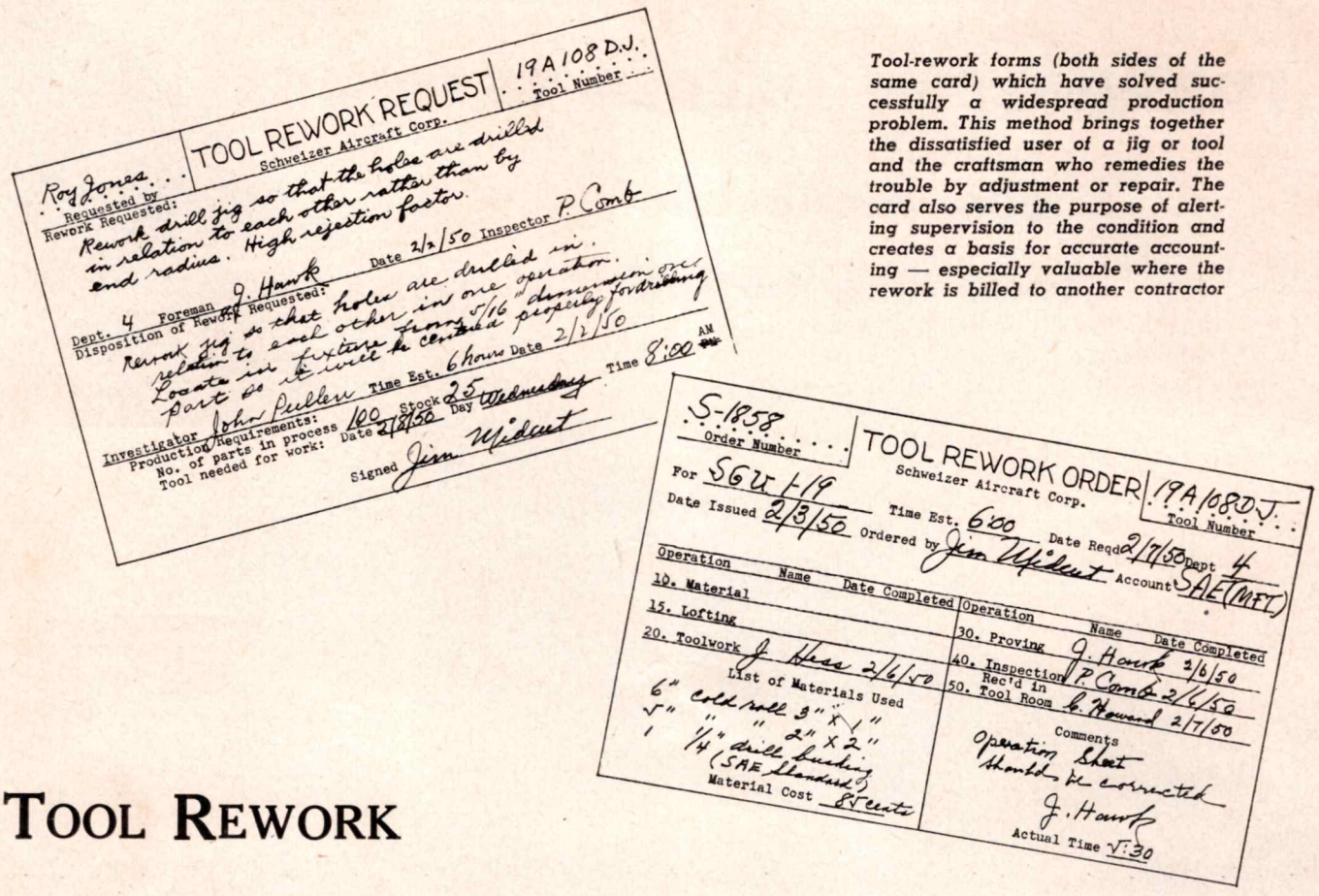
THE TORRINGTON COMPANY

Torrington, Conn. • South Bend 21, Ind.

District Offices and Distributors in Principal Cities of United States and Canada

TORRINGTON *NEEDLE* BEARINGS

NEEDLE • SPHERICAL ROLLER • TAPERED ROLLER • STRAIGHT ROLLER • BALL • NEEDLE ROLLERS


TOOL REWORK REQUEST
Schweizer Aircraft Corp.
19A108 D.J.
Tool Number
Roy Jones
Requested by
Rework Requested: Rework drill jig so that the holes are drilled in relation to each other rather than by end radius. High rejection factor.
Dept. 4 Foreman J. Hawk Requested: P. Comb
Disposition of Rework: Rework jig so that holes are drilled in relation to each other in one operation. Locate in fixture from 5/16 dimension over part to be well located properly for drilling
Date 2/2/50
Investigator John Fuller Time Est. 6 hours Date 2/2/50 Time 8:00 AM
Production Requirements: No. of parts in process 100 Stock 25 Day Wednesday
Tool needed for work: Date 2/3/50
Signed Jim Wisdent

S-1858
Order Number
TOOL REWORK ORDER
Schweizer Aircraft Corp.
19A108DJ
Tool Number
For SGU-19
Time Est. 6:00
Date Issued 2/3/50
Ordered by Jim Wisdent
Date Reqd 2/7/50 Dept 4
Account SAE (MFT)

Operation	Name	Date Completed	Operation	Name	Date Completed
10. Material			30. Proving	J. Hawk	2/6/50
15. Lofting			40. Inspection	P. Comb	2/6/50
20. Toolwork	J. Hess	2/6/50	Rec'd in 50. Tool Room	L. Howard	2/7/50

List of Materials Used
6" cold roll 3" x 1"
√ " " 2" x 2"
1 1/4" drill bushing (SAE Standard)
Material Cost 85 cents

Comments
Operation sheet should be corrected
J. Hawk
Actual Time √:30

Tool-rework forms (both sides of the same card) which have solved successfully a widespread production problem. This method brings together the dissatisfied user of a jig or tool and the craftsman who remedies the trouble by adjustment or repair. The card also serves the purpose of alerting supervision to the condition and creates a basis for accurate accounting — especially valuable where the rework is billed to another contractor

TOOL REWORK

Can Meet Production Requirements

WILLIAM SCHWEIZER

Industrial Management Instructor, Long Island Agriculture & Technical Institute

REWORK and maintenance of production jigs and fixtures in the aircraft industry make up a notoriously inefficient operation. It is not uncommon to hear a production foreman say, "I've had this jig in the toolroom and they've reworked everything but what's really necessary!"

Many tool defects have a way of showing up only when tools are used in production. If the toolman doing the rework knows the point from which to work, some of these defects often can be corrected by a minor adjustment. Otherwise, he may need to disassemble the tool completely, which might result in new problems or the reoccurence of the original defect.

Another common problem is that defects, which could have been called to the attention of production management earlier, frequently do not show up until tools are ready to be reused. The craftsman's mechanical problems involved in making jigs and fixtures function effectively are usually considered the most difficult in manufacturing. Therefore, the control involved in this operation should be studied closely. When tools are not ready for the job, the company may not lose the operator's time, but costly equipment will stand idle and production schedules will not be met. This results in a mushrooming of factory costs.

Condoning a Fault

One of the basic reasons for the existence of this problem is the tendency of management to go along with a tool department which pays little attention to the comments of production and inspection personnel. At Schweizer Aircraft Corp., Elmira, N. Y., this problem has been met successfully by developing a rework procedure which indirectly forces the toolman doing the rework to consider the comments of the man using the tool.

This company realizes that the personnel involved in production and inspection often do not have the background to determine the reasons for defects and have a tendency to dream up impractical solutions to correct them. However, they do have the actual experience of knowing what happens when the tools are in use, and inspection can provide factual information regarding deviations of the product. Their comments, therefore, should be evaluated in light of the tool rework.

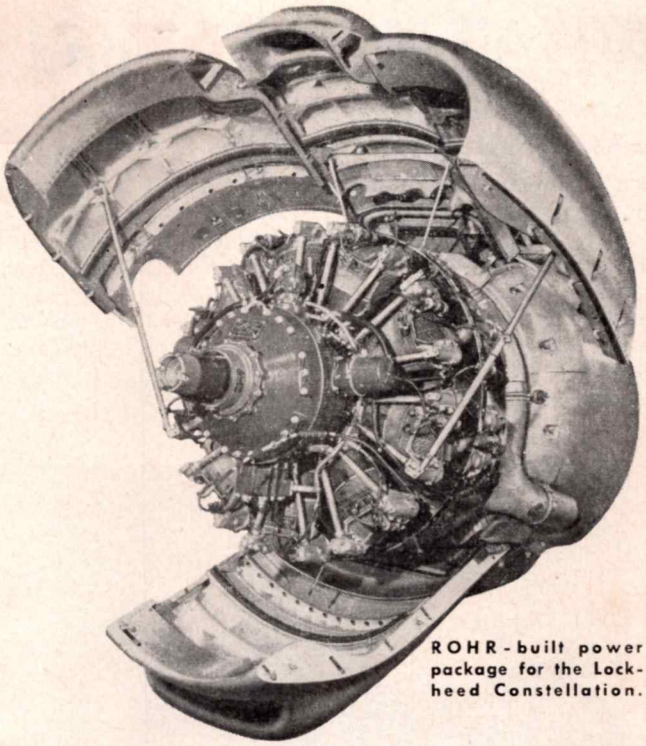
At the Schweizer plant, tool-rework request forms are available in every department throughout the plant, so that anyone easily can suggest a rework in writing. The rework request is then investigated by a tool liaison man and a definite disposition is made. A small percentage of these reworks always will be found unnecessary, but the majority will prove to be advantageous.

This free exchange of information, stimulated by the took-rework procedure, tends to suggest preventive maintenance that can be scheduled at the convenience of production to help avoid breakdowns. It is also in line with a basic principle of good management which states that all parties

(Continued on page 86)

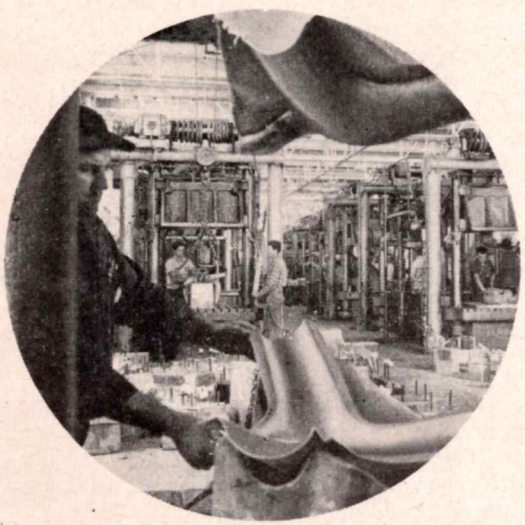
BETTER! FASTER! CHEAPER!

An Exhaust System . . . a Complete Power Package — ROHR builds these and other products for such famous names in Aviation as Boeing, Convair, Lockheed, North American and many more. ROHR'S proven production skills, equipment, engineering ability and experience are available to you, too. When it's made of metal . . . and you want it better! faster! cheaper! wire, write or telephone ROHR.



ROHR-built power package for the Lockheed Constellation.

ROHR



ROHR

AIRCRAFT CORPORATION

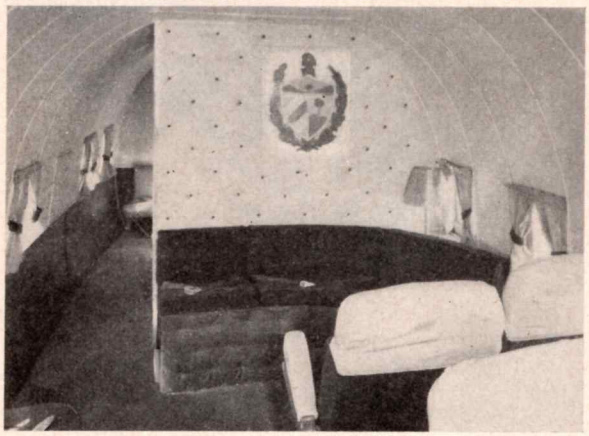
In Chula Vista, California . . . 9 miles from San Diego

One of the many ROHR-designed drop hammers now in operation at ROHR.

WHAT'S UP... and WHAT'S GOING UP

Fokker Activities

Due to the curtailment of the Dutch aviation budget and decreased government subsidies, Fokker Aircraft of Amsterdam has shelved many development plans. Currently in production is the S-11 *Instructor*, a side-by-side basic trainer. Prototypes under construction include the S-13 twin-engine crew trainer and the S-14 side-by-side jet trainer. Fokker also is building Gloster *Meteors* and Hawker *Sea Furies* under contract to Great Britain for the Benelux air forces. (AERO DIGEST, June 1948).



"El Mambi"

The President of Cuba, Dr. Carlos Prio Socarras, has accepted delivery of a custom-modified Douglas C-47 tailored to his own specifications. American Airmotive Corp. of Miami, Fla., did the converting, combining luxury with functionality. A galley with stove and refrigerator is located aft of the radio compartment. Behind this, completely enclosed, is the President's compartment, comprising two lounges and a passenger cabin for his executive staff. The ship is named *El Mambi*, literally translated as "patriot" or "liberator."

Folding Tail

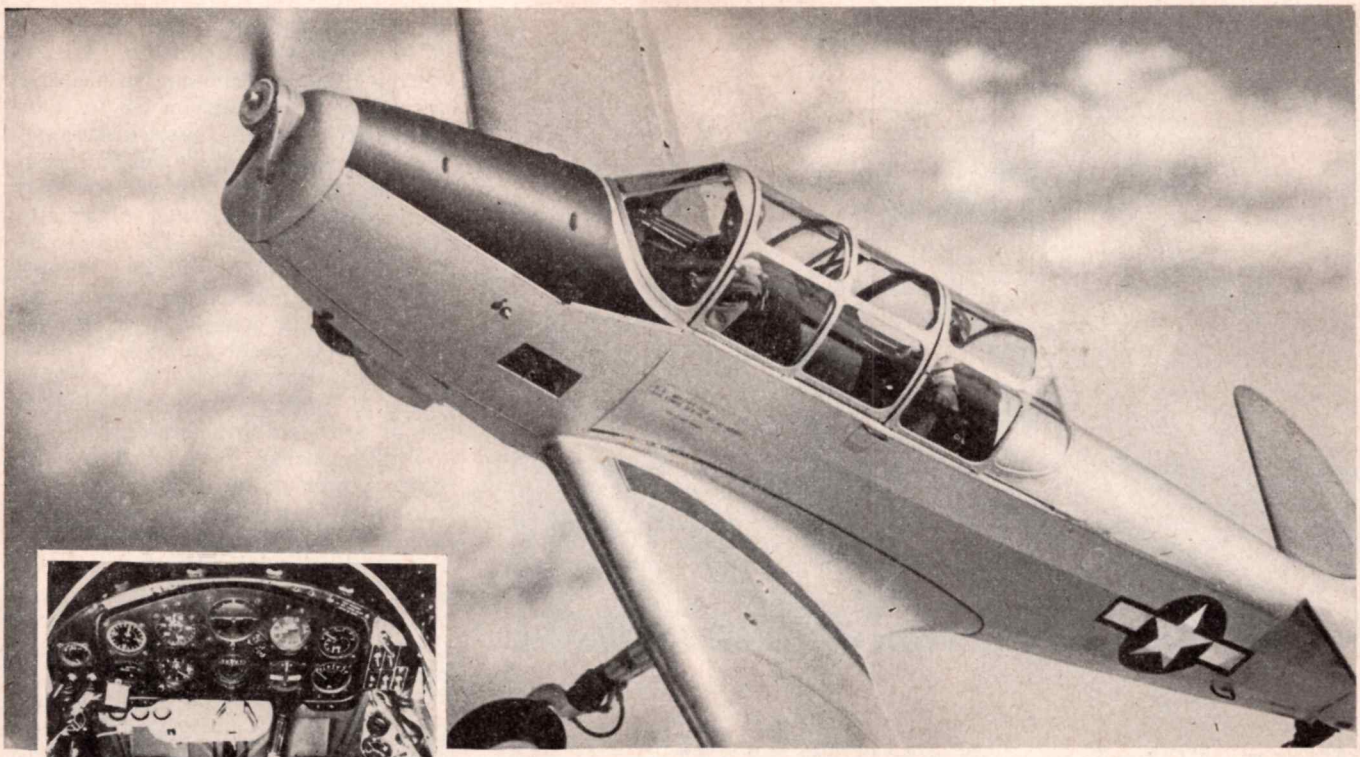
Boeing engineers, realizing that no hangars had been built to accommodate the 38-*ft* tail of their *Stratocruiser*, handled the situation nicely by fitting it with a hinge. Four holding bolts can be disengaged, and the tail assembly slowly folds down to the right, controlled by a jack that can be operated by one man. Holding bolts can only be disengaged on the ground and height of aircraft is reduced by 11 *ft* 3 *in.*

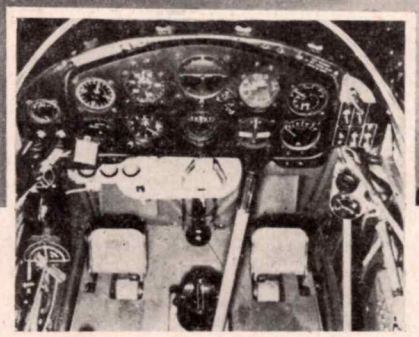
Air Guard "Thunderjets"

Fifty pilots and 150 airmen of the Air National Guard have been given transitional training at Shaw AFB, S. C. during the past two months in the operation and maintenance of Republic F-84 *Thunderjets*, in preparation for the assignment of these aircraft to ANG fighter squadrons. The training is being done by the USAF 20th Fighter Group, which has been equipped with *Thunderjets* since 1948, and will consist of a series of fortnightly classes, using both aircraft and a mobile training unit. F-84C's and D's have been overhauled completely and modernized by Republic and, between now and March 21, will be delivered to ANG fighter squadrons in the following States: Delaware, Georgia, Iowa, Kansas, Massachusetts, Michigan, New Jersey, New York, Ohio, Oklahoma, Washington and the District of Columbia. California, Florida, Maine, Nebraska and Wisconsin Air National Guards are scheduled to get Lockheed F-80's.

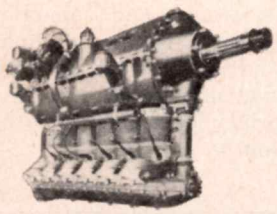
Briefs

NWA is making substantial mileage savings, using Boeing *Stratocruisers*. Cruising at 20,000-25,000 *ft*, pilots fly direct rather than via airways and save up to 125 *mi* on each leg of their transcontinental routes . . . Baumann Aircraft, Glendale, Calif., has sold its Model B-250 *Brigadier* to Piper Aircraft for experimentation; Baumann is now pushing construction of production Model B-290, which will sell for $20,000 . . . First production model of TEMCO T-35 *Buckaroo*, destined for foreign services, will be shipped to the Philippine Air Force for evaluation tests . . . Canadian Pacific Airlines is to use 48-passenger de-Havilland *Comet* jet transports on its Vancouver-Hong Kong route, via Alaska and Japan; delivery is expected in 1952 . . . BOAC has ordered 14 *Comets* . . . Bellanca has demonstrated a new 4-place executive model powered by a 190-*hp* Lycoming that not only cruises at 180 *mph*, but also can fly at 43 *mph*. Lines Aeree Italiane, an Italian airline, has ordered three DC-6 transports for a transatlantic service . . . Capital Airlines' new Super DC-3's are equipped with cross-wind landing gear . . . United Air Lines is using Boeing *Stratocruisers* on its California-Hawaii route; de luxe service will accommodate 55 passengers . . . UAL is set to buy six Douglas DC-6B *Liftmasters* . . . French Arsenal VG-90 carrier fighter recently made its second test flight, powered by Hispano *Nene* rated at 5000 *lbs* thrust . . . Sud-Est SE-2410 twin-jet fighter also is being test-flown; aircraft features unique engine arrangement of two *Nenes* mounted one above the other in fuselage . . . Ryan has added new "Utility 205" model of *Navion*, powered by Continental; with less elaborate outfitting, it will sell for $9485.





MILITARY PILOTS NEED TO GET THE FEEL OF TACTICAL AIRCRAFT RIGHT FROM THE START



Large Supply
Ranger Engines
In Stock

All Babb's
PT-19—PT-26 Parts
Carefully Warehoused

Fairchild designed Cornell PT-26A primary trainers to give student-pilots, from their first day of flight, the feel of big tactical aircraft. The roomy cockpit with a full complement of instruments — the fighter type canopy—the low wing—the three-position flaps—all add up to that big plane feel. Yet, hourly operation and maintenance costs for this aircraft are so economical, that flight instructors are able to give their students the extra hours in the air that make air-wise pilots—even on limited appropriations. Carefully compiled cost data definitely indicate that Air Force Training Commanders should investigate Fairchild designed Cornell PT-26A primary trainers before making a decision.

The Babb Company can supply a number of completely overhauled PT-26A's, plus complete stocks of spares for the airframe and engine of this aircraft.

COPIES AVAILABLE

AVIATION SALES — SERVICE
BABB

THE BABB COMPANY, INC.
1007 Airway — Glendale, Calif.
444 Madison Avenue,
New York, 22, N. Y.

WASHINGTON MONTREAL AMSTERDAM GENEVA HONOLULU

Test Flight of the "Helidyne"

THE GYRODYNE CO. OF AMERICA has submitted its Model 7 *Helidyne* as its entry in the USAF Arctic Rescue Evaluation. The *Helidyne* made its initial flight on Nov. 30, 1949, and merits attention because it constitutes a first step in evolution towards a true "Convertaplane."

The model flies as a helicopter of the coaxial type, with two 2-bladed rotors of the see-saw or "teetering" type. We understand, rather informally, that it flew at a gross weight of 5700 *lbs* and was powered by a Pratt & Whitney 450-*hp* engine. The intial flights were considered satisfactory.

The production model, in its ultimate form, will be powered by two 375-*hp* Lycoming engines, mounted in streamlined nacelles. The three-bladed propellers will be pushers. A fixed wing will support the engine nacelles, and will have an area of 75 *sq ft* or some 5-6% of the rotor-disk area. The empennage will be of the regular airplane type, though mounted more closely to the center of gravity than in an airplane. The transmission system is of especial interest, with clutches between the engine and the main rotor and between the engine and the pusher propellers.

The principles which Peter J. Papadakos is seeking to put into practice are of considerable interest.

With propellers de-clutched and the entire power of the engine going to the rotors, he will have a conventional helicopter for landings, takeoffs and low-speed operation. For fast forward flight, the propellers will be engaged, the wing will pick up lift, unloading the rotors, and the airplane-type empennage will become effective.

As Dr. Hohenemser stated at the Convertible Aircraft Congress, such use of conventional propellers, and a fixed wing in combination with lifting rotors, removes, or postpones appreciably, the limitation on forward speed that exists because of retreating blade stall. Appreciable increase in high speed over that of the conventional helicopter should be possible.

It is a remarkable and encouraging coincidence that a paper should have been read advocating certain principles, and that an aircraft embodying the same principles should have been flown at about the same time!

AIR MEETINGS AND EVENTS

February

16—Aviation Law Clinic. Sponsored by the Chicago Bar Assn. and Illinois State Bar Assn. 29 S. LaSalle St., Chicago.

18-26—New York Airplane Show (part of Annual Sportsmen's Show). Grand Central Palace, New York.

27-(through March 3)—American Society for Testing Materials Committee. Week and Spring Meeting. Hotel William Penn, Pittsburgh, Pa.

March

1-2—Louisiana Aviation Conference. Washington-Youree Hotel, Shreveport, La.

6-9—American Road Builders Assn. Annual Meeting (including Airport Division). Netherlands Plaza Hotel, Cincinnati, Ohio.

18—National Model Plane Exhibit Contest. Higbee Co. Auditorium, Cleveland, Ohio.

24—Institute of the Aeronautical Sciences. 5th Annual Flight Propulsion Meeting. Hotel Carter, Cleveland, Ohio.

28-31—4th National Plastics Exposition. Sponsored by the Society of the Plastics Industry. Navy Pier, Chicago, Ill.

28-31—New York's 20th Annual Safety Convention and Exposition. Sponsored by the Greater New York Safety Council. Statler and Governor Clinton Hotels, New York City.

30-31—American Helicopter Society Annual Forum. Ben. Franklin Hotel, Philadelphia.

April

4-6—Air Transport Assn. Annual Engineering and Maintenance Conference, Hotel Continental, Kansas City, Mo.

4-8—National Production Exposition. Sponsored by the Chicago Technical Societies Council. Stevens Hotel, Chicago.

10-14—American Society of Tool Engineers Exposition. Convention Hall, Philadelphia.

16-20—22nd Annual Business Meeting. American Assn. of Airport Executives. Neil House Hotel, Columbus, Ohio.

17-19—Society of Automotive Engineers. Aeronautical Meeting and Aircraft Engineering Display, Hotel Statler, New York.

May

5-6—Midwestern Conference on Fluid Dynamics and National Meeting, American Physical Society, Fluid Dynamics Div. University of Illinois, Urbana, Ill.

28-(through June 4)—Federation Aeronautique Internationale Conference. Stockholm, Sweden.

June

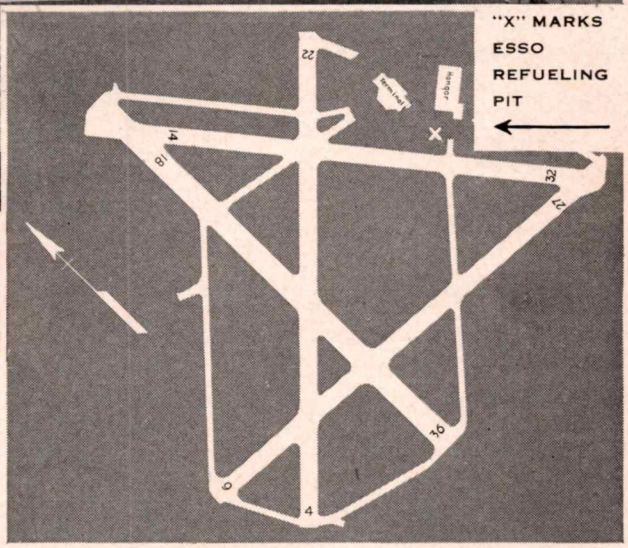
4-9—Society of Automotive Engineers. Summer Meeting. French Lick Springs Hotel, French Lick, Ind.

10-13—National Aeronautic Assn. Convention. Hotel Statler, St. Louis, Mo.

26-30—American Society for Testing Materials. 9th Exhibit of Testing Apparatus and Related Equipment. Chalfonte-Haddon Hall, Atlantic City, N. J.

BETTER SERVICE MEANS "HAPPIER LANDINGS" AT THIS IMPORTANT AIRPORT!

TERMINAL BUILDING

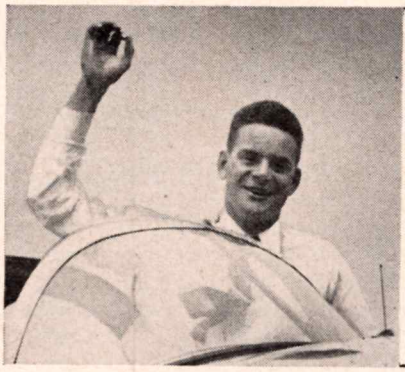


BALTIMORE MUNICIPAL AIRPORT

BALTIMORE, MARYLAND

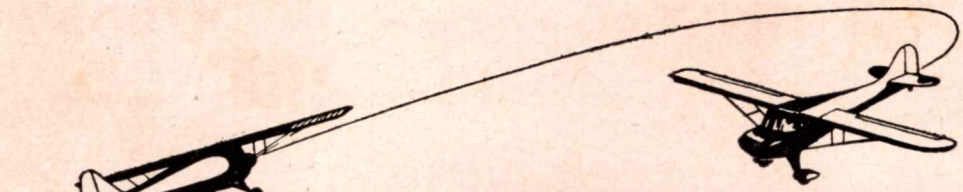
CONVENIENCE... COMFORT... SERVICE! You want the best of all these things wherever you land. And at the efficiently operated Baltimore Municipal Airport, the Atlantic Aircraft Distributors, Inc. makes it its business to provide excellent hangar and tie-down facilities... aircraft and engine repairs by skilled, licensed mechanics... fast, dependable maintenance with good aviation products.

ALWAYS AVAILABLE at Baltimore Municipal Airport are high-quality Esso Aviation Products. Proved by more than 40 years of actual flying... backed by continuing research in America's largest and most modern aviation petroleum laboratories... Esso Aviation Products are known for dependable performance!

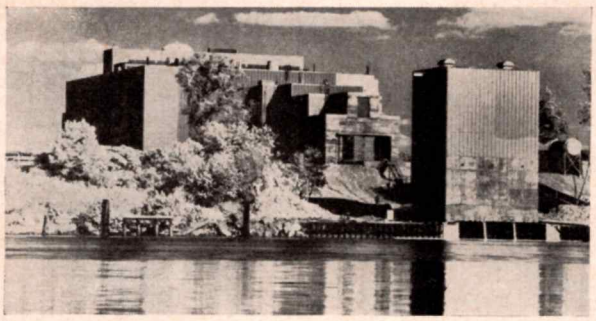


PHIL ANDERSON, owner of Atlantic Aircraft Distributors, Inc. which sells Esso Aviation Products exclusively at Baltimore Municipal Airport.

WHENEVER YOU LAND at Baltimore Municipal, you'll find efficient traffic handling 24 hours a day by the CAA operated tower and weather station... a good restaurant right in the Terminal Building... and convenient bus and limousine service.



TAKEOFFS AND TURNS



New Jet-Engine Lab

Pratt & Whitney Div. of United Aircraft will begin testing jet engines shortly in the new Wilgoos Turbine Laboratory on the Connecticut River at East Hartford. Named after the late P&W chief engineer, the 12-million-dollar lab was designed specifically for jet-engine testing, is six stories high, 400 *ft* long and 166 *ft* wide.

Aeromatic Propeller Flanges

CAA Airworthiness Directives have been issued in an attempt to prevent recurrence of flange failure on *Aeromatic* Model F200 propellers. It was decided that the most economical and expedient way would be to modify the flange. The newly-designed part (No. 3277-1) has been subjected to over 22 million vibration cycles at an engine torsional amplitude of —1°. From investigations made by Aeromatic and the CAA, it has been shown that failures were not attributable to faulty propeller design or construction, but rather to a critical fourth-order vibration frequency in certain engine-propeller combinations at high *rpm* after about 500 *hrs* operation.

Briefs

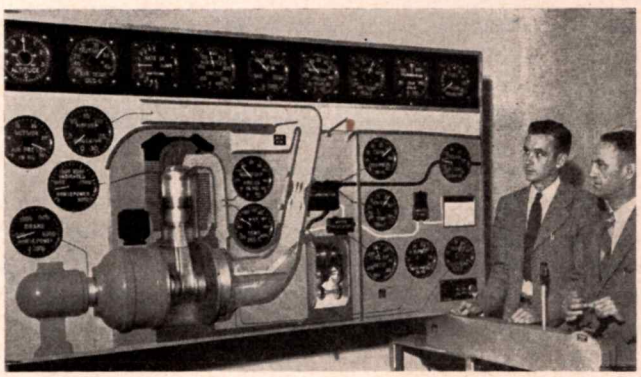
An Air Force officer in the Research and Development Section at Randolph AFB, Texas, has developed a new type of instrument-flight training goggles by inserting blue *plexiglass* in the frame of GI sun glasses and attaching side blinders, thus eliminating fogging and increasing comfort. . . . An RPI aeronautical engineering professor has been granted the patent on the stall-warning indicator developed in conjunction with W. & L. E. Gurley Co. . . . Pacific Airmotive Corp. and Stratos Corp. announce a technical-assistance agreement in the design manufacturing and service of aircraft pressurization and air-conditioning equipment. . . . MATS has renewed scheduled service between the U. S. and South America—one route to Santiago, Chile, via Ecuador and Peru; another to Buenos Aires, Argentina, via Puerto Rico, B.W.I. and Brazil. . . . Jan. 21 was the 29th anniversary of the U. S. Junior Chamber of Commerce, one of aviation's biggest boosters—their slogan: Young Men—Action! Every town, city and state Jaycee unit has active aviation committee.

What's The Good Word!

The Psychology Branch of CAA's Medical Div. is attempting to construct a standard vocabulary for aeronautical communications, on the thesis that certain words have a much higher degree of intelligibility than others. Project has particular timeliness, as ICAO has requested that the U. S. recommend a standard English vocabulary for use in world aviation.

Media

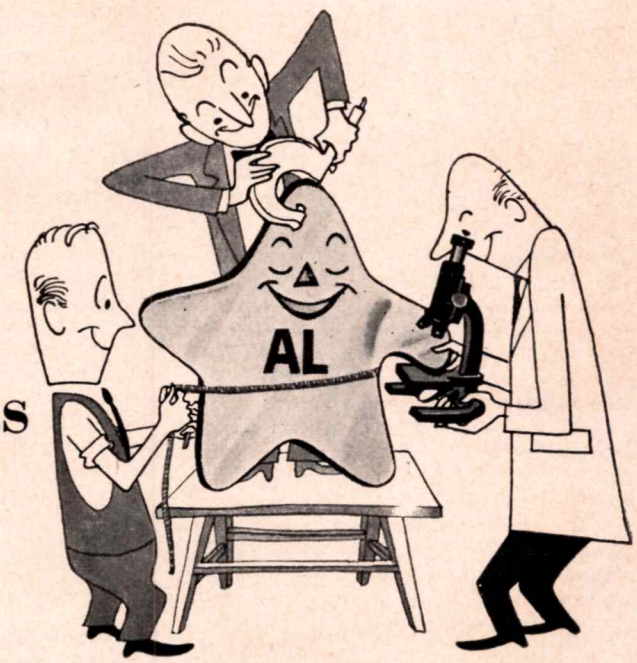
CAA has published Airframe and Equipment Engineering Report No. 45 on *Simplified Flutter Prevention Criteria for Personal Aircraft*, for manufacturers. . . . CAR Amendment 45-1 classifies commercial operators in intrastate traffic in the same safety category as certificated feeder lines. . . . Civil Aeronautics Manual 43, Section 10 has been amended to conform with Section 43.10c, CAR *Certificates and Identification Marks*. . . . Library of Congress has published 33-page booklet describing history and contents of *The General Spaatz Collection* of historical documents, correspondence, photographs and personal diaries for the period 1922-1948. . . . Nov. issue of *NEA Journal* carries revealing article on air-age education in California by W. N. McGowan. . . . Eastman Kodak has released a new motion picture entitled *Functional Photography in Industry*, surveying ways photography is used in research, production, quality control, advertising and sales.



Synthetic Trainer

Newton Co., of Middletown, Conn., has developed a new synthetic device to teach pilots and flight engineers the finer points of proper engine-operating procedures. The Newton trainer can calculate practically all the physical reactions of P&W R-2800-34W *Double Wasp*, but shows on the instrument panel only those of specific student interest. The trainer is actually an analogue computer and enables pilots to determine best economy, cruise and maximum power, mixture and propeller settings, the effects of supercharging in high and low blower, purpose and effects of water injection and methods of preventing and eliminating carburetor ice.

There's only one family of Stainless Steels that will meet all your requirements



ALLEGHENY METAL is the *only* stainless steel that is produced in every commercial grade and finish—and more especially, in every shape or form that a fabricator may need.

From *one* source, therefore, you can get everything . . . sheets, strip, plates, bars, wire, shapes, fine wire, tubes, castings or forgings—in the type of stainless steel that the service conditions require. What's more, you can get it *now* . . . Allegheny Metal is promptly available to your order.

Use this convenient, one-stop source of supply for stainless steel—the clean, strong, shining metal that's cheapest in the long run because it *lasts* longest. • When you're in the market for stainless, think first of Allegheny Metal.

W&D 2342 *Complete technical and fabricating data—engineering help, too—yours for the asking.*

ALLEGHENY LUDLUM STEEL CORPORATION

The Nation's Leading Producer of Stainless Steel in All Forms

AL

Pittsburgh, Pa. . . . Offices in Principal Cities

Allegheny Metal is stocked by all Jos. T. Ryerson & Son, Inc., Warehouses

REACTION

(Continued from page 50)

turbine elements. The main purpose is to test the company's new heat-resistant product, *Kentanium*, under operational conditions.

The test turbine will have its main elements constructed of the new metal, which is said to have a high resistance to oxidation and retains an unusual strength at elevated temperatures. This makes feasible an operation at 2200° *F* and the attainment of greater engine efficiency. In addition, it withstands thermal shock well and weighs less than conventional heat-resistant materials. All of which adds up to a lighter, more compact unit for a given power output.

The research engine is being built and used as an especial service to potential users of *Kentanium* in the jet-powerplant field.

TRAVEL SURVEY

(Continued from page 19)

above group had flown on commercial airlines before, and close to 20% had made previous transatlantic flights.) Students, housewives and white-collar workers accounted for the rest of the passengers.

Flying turns out to be a family affair with these travelers. Almost half said their wives (or husbands) had flown, too—and of these, three out of four had enjoyed their flights.

Passengers on the return leg of their trip were asked how long they'd been away. The greatest number (more than 50%) had stayed away between one and three months. A small but striking illustration of transatlantic air-travel possibilities was seen in the 2% who had been away less than a week—and the 10%, less than two weeks.

When asked why they chose air transportation, nearly 80% replied "speed" or "lack of time." That figure went up to 90% for business travelers alone. Once on their way, however, many seemed to take the time they were saving for granted. On another question, "What do you specifically like about the air trip?" only 44% mentioned speed.

Their transatlantic trip was far more comfortable than most passengers thought it would be. Only 2% had "comfort" in mind when they selected air, but 19% specifically mentioned it near the completion of the trip and another 24% were pleased by the courtesy and kindness of airline personnel. Food, safety and the actual experience of flying were named also as contributing to the enjoyment of the trip. In all, better than eight out of ten agreed that they were thoroughly pleased with the trip by air.

"Fatiguing" (23%) and "uncomfortable" (18%) led the list of complaints, with "air sickness," "delays" and "boring" not far behind. Many passengers thought the long hop between Shannon and Gander too tedious, and some offered suggestions, practical and not-so-practical, for "shortening" it—better reading material, commercial radio, movies, television. A frequently-repeated suggestion was for better and more current reading material on planes.

An almost unanimous criticism concerned the lack of space inside the cabin—for passengers' own comfort and for hand luggage, too. Most repliers felt that the length of the trip justified an extra inch or two of room per passenger, since many had brought small gifts and overnight kits aboard.

Either as a time-killer or out of genuine curiosity, both men and women expressed interest in such items as geographical position, height of plane and flying speed. Maps, or occasional flight notes from the pilot, were suggested as a simple way to correct this minor grievance, although one male passenger wishfully requested a luminescent diagram on which to follow his flight.

Comments on meal service ranged from lukewarm to mildly enthusiastic. In general, replies were negative and often specific—coffee cold, food starchy, eggs rancid, rolls stale. A couple of remarks that food is not up to the standard expected on airlines indicated that meals are better on domestic runs. Several passengers on various airlines offered to pay for their food, if that would improve its quality.

A major complaint concerned baggage in all its aspects. Most found the weight allowance too low and too strict—and disliked the limit on personal effects permitted inside the cabin. In one instance, a family paid fare for their baby but was given no weight allowance on that fare. (Perhaps it bears no relation, but their next comment was that free martinis helped a lot!) Another suggested that luggage could be handled more carefully as new bags had been unnecessarily damaged.

A good many people had definite ideas about additional comforts they'd like to see installed. Again and again, passengers asked for footrests on overnight flights, and several even offered their own designs.

Ground facilities came in for criticism, also. Many thought European rest rooms definitely below par and suggested improvements. Another repeated request was for limited banking service to cash small foreign currency and travelers' checks. Several persons were unable to buy snacks at the stopping places because their currency was not acceptable.

Although exceptional service never failed to impress passengers, an occasional unfriendly airline employee made a lasting, not-so-favorable impression. Prevailing opinion, however, was summed up in the statement of one man: "Service is excellent. Much improved since war. A pleasure to travel this way, now."

In general, passengers realize the difficulties airlines are up against and are willing to pay for any extra privileges. Since ocean hops differ greatly from domestic air travel, they seemed to enjoy sounding-off on the personal touches that might make the trip more pleasant.

And although they expressed dissatisfaction here and there, the total effect was evidently pleasing—for almost 70% said they'd like to fly abroad again next time.

WASHINGTON

(Continued from page 30)

For that reason, appropriations have to increase for a procurement volume comparable with that of prior years. It is obvious that present volume can not maintain our air fleets, dwindling by attrition and obsolescence.

Though the air-policy plans in 1948 were based on building by the end of 1952 to a complement of 20,541 Air Force and 14,500 Naval planes, the 1951 budget calls for operation of 8800 planes by the Air Force and its reserve components, while Naval Aviation would operate 5900 aircraft plus 2500 for its reserves.

Air Force strength is to be 48 groups and 13 separate squadrons. The Budget Book reiterates Truman's determination to hold to the 48-group program, announced shockingly a year ago after Congress had approved building toward the full 70 groups.

Policy-Plan Comparison

For fiscal 1951, the Air Force gets $1,700 million in aircraft-procurement appropriations and $610 million in contract authorizations. Naval-aircraft procurement gets $620 million cash and $475 million contract.

Comparable figures for 1950 are: Air Force $1100 million cash and $1992 million contract; Naval aircraft, $523 million cash and $576 million contract. The increases in 1951 appropriations in each case are to cover work previously contracted. Note that contract authority has stepped down.

Also, $726 million of 1950 Air Force contract authority was impounded after the House vote for a 58- rather than a 48-group program. Hence, the way is pointed toward a dwindling program in future years.

The air-policy plan, instead, called for an expanding program to modernize the air arms by 1953 and level off thereafter. Following is a comparison between the recommendations of the Congressional Aviation Policy Board and the budgets, present and pending:

Aircraft Procurement
(In billions of dollars)

	Fiscal *1950*	Fiscal *1951*
Policy Plan A	2.65	3.79
	3.64	4.41
Policy Plan B	2.37	3.38
	3.37	3.97
Budget	1.62	2.32
	*2.57	1.08

* Includes .72 impounded.

The difference between Plans *A* and *B* is in the aircraft reserve that would be maintained. In any event, it is evident that the levels recommended, or the higher levels required next year toward the 1953 deadline, are not even approached by the budget.

Research and Reserves

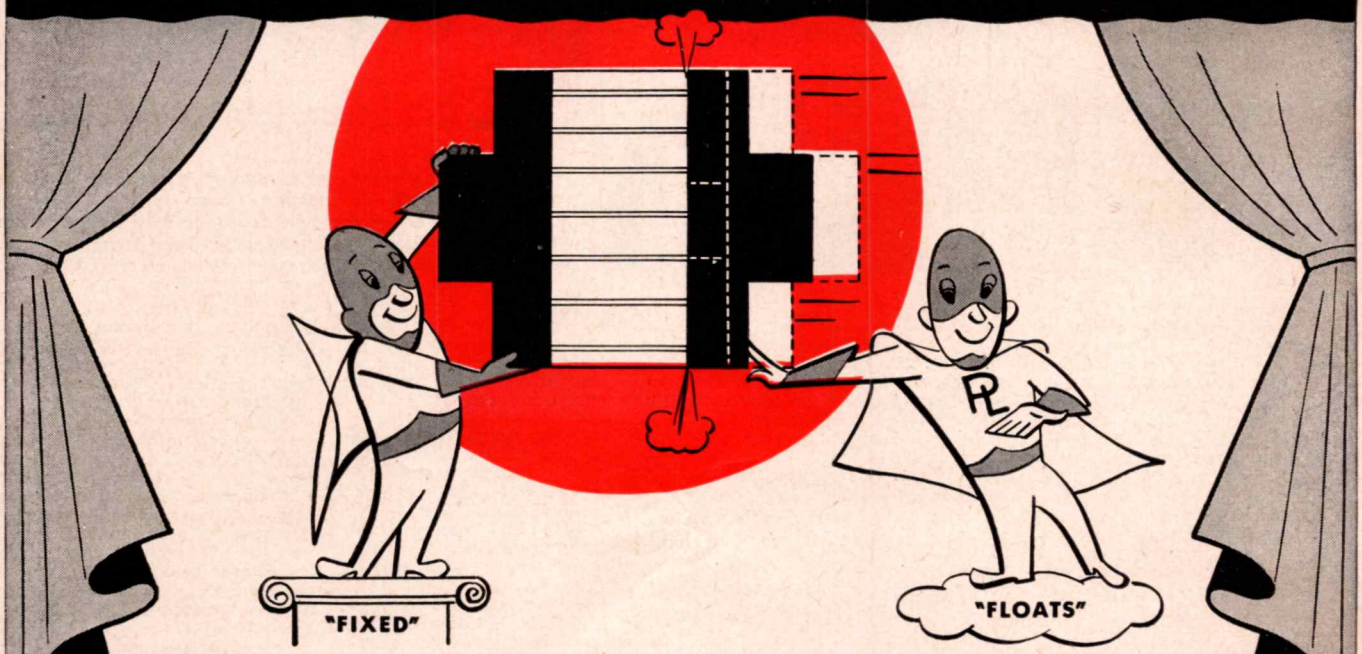
There is a good deal to be said, of course, for going light on present aircraft, soon to be made obsolete by future jets and missiles. Air power on the drawing board is no insurance against attack—might be even the opposite to an enemy intent on destroying us before we improve our arms.

Yet, to the extent that there are economies in the regular forces to be maintained, the more important it is to develop super weapons. More will be heard in Congress about "R & R"—Research and Reserves.

For fiscal 1951, however, the total Armed Services budget for research and development, at $606 million, is slightly less than

(Continued on page 74)

MEET THE "PL"* TWINS



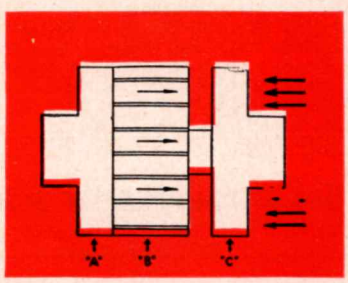
...The Greatest Little Act in Hydraulics

Yes, sir, "Fixed" and "Floats" are the famous "PL"* twins, Pesco's exclusive hydraulic pump act that provides volumetric efficiencies up to 97% . . . torque efficiencies up to 90% . . . and assures these efficiencies over a longer service life.

"Fixed" is an old-timer at this kind of an act. But it's "Floats" that really wows 'em. He's the one that *automatically* holds end clearance to a thin film of oil, making possible maximum torque and operating efficiencies under all operating conditions. Together, "Fixed" and "Floats" make possible Pesco's patented "Pressure Loading" principle of construction for gear-type hydraulic pumps. Here's their act:

*"PRESSURE LOADING"... How it works

The schematic illustration at right shows the three principal parts of a gear-type hydraulic pump. They are the bearings ("A" played by "Fixed" and "C" played by "Floats") and the gear ("B"). Bearing "A" is fixed. Bearing "C" floats. By means of the "Pressure Loading" principle, pressure from the discharge of the pump is transmitted through a "Pressure Loading" passage and is exerted against the rear of the "floating" bearing. This force is counter-balanced by pressure developed within the gear cavity so that the thrust of the bearing against the gears is just enough to accomplish its purpose.



ONLY PESCO PUMPS ARE "PRESSURE LOADED"

"Pressure Loading" is the answer to safer, more efficient, more economical aircraft operation. Why not get the full story today. No obligation, of course.

Pesco PRODUCTS DIVISION
BORG-WARNER CORPORATION
24700 North Miles Rd. • BEDFORD, OHIO

BOOKS

This streamlined service is conducted in response to many requests for books on aviation. Items mentioned may be purchased by using convenient coupon below. Prices are all publisher's list at review time, but may change without notice. Mail orders must be prepaid with checks or P.O. drafts.

Symposium on Deformation of Metals as Related to Forming and Service. ASTM Special Technical Publication No. 87. 117 pp; illus. $2.—Papers and discussions presented at the 51st Annual Meeting of the American Society for Testing Materials at Detroit, June 22, 1948. Two of the studies relate to ship construction, two more to measurement and bulge-testing of sheet metals generally, and a fifth concerns notched-bar tension tests on annealed carbon-steel specimens. Authoritative and important in its field.

Aircraft Maintenance and Service. By Rollen H. Drake. 352 pp; illus; index. $6.—The 6th in Col. Drake's 7-vol. "Aircraft Mechanic Services," and fully up to the standards set by its admirable predecessors. The work is painstaking, thorough and expressed with great clarity. Technical terms are used sparingly. While it is addressed mainly to school use, it will be valuable also to the practicing mechanic who likes to keep a basic refresher text at hand. It is claimed that this book will furnish all material necessary to qualify for a CAA aircraft-mechanic certificate.

The Struggle for Guadalcanal: Aug. 1942-Feb. 1943. By Samuel Eliot Morison. 389 pp; illus; folding map; index. $6.—Vol. V in the projected 14-vol. "History of United States Naval Operations in World War II" by Capt. Morison, who is Jonathan Trumbull, Professor of American History at Harvard. Authoritative, scholarly and vivid, as in all previous volumes in this series. The present work covers six months of Naval service in the Pacific, during which as many major engagements with the enemy occurred — the 3-day battle of Guadalcanal, the carrier battle of the Eastern Solomons, the battle of Cape Esperance, that of the Santa Cruz Islands, and those of Tassafaronga and Rennell Island.

The Old Breed: A History of the 1st Marine Division in World War II. By George McMillan. 483 pp; illus; appendices. $6.50.—One of the most beautifully done works of its extensive kind, not just in writing and illustration but in format. The account of the soul-searing experiences of this great American division in the Pacific Theatre is developed with a profusion of warm - hearted anecdotes and a lavishness of well-chosen pictures made by combat artists and photographers. The author, a newspaperman before the war, joined the Marines in 1943 as a combat correspondent for the Cape Gloucester operation, and emerged late in 1945 as a Technical Sergeant. The appendices include citations of the Medal of Honor men and listings of other recipients of decorations and awards, together with an index "in memoriam."

Official Air Cargo Station Directory. Issued by Air Cargo, Inc. for Its 22 Certificated Member Airlines. 49 pp; incl. monthly revisions, $10. — For the use of airline personnel and the shipping public. Contains complete listings of all airport cities, together with types and capacities of aircraft serving each city; availability and size of cargo-handling equipment; rail- and motor-transfer facilities for on-shipment to other than airport cities, and more. Each airline's equipment and maximum package weight and size limitations are tabulated, along with complete cargo flight schedules.

Airport Operators Council: Papers Presented and a Selective Discussion Report Covering the 2nd Annual Meeting, Denver, Col., May 2-4, 1949. 145 pp; illus. $2.50.—A lot of good, realistic discussion of airport problems, ranging from physical development to economic and operating headaches. Those who attended the annual meeting came from throughout the country; what they had to discuss consequently provides not only a cross-section of airport opinion but a remarkable variety of first-hand experience in many difficult situations. Really worthwhile.

Airplane Performance, Stability and Control. By Courtland D. Perkins and Robert E. Page. 493 pp; diagrams; index. $7.—In two sections, *(1)* the design of airplanes for performance and *(2)* design for flying qualities, a comparatively new art. The book is based largely on material developed by the authors while working together in the Aerodynamics Branch of the USAF Materiel Command at Wright Field. C. D. Perkins is professor in the engineering department at Princeton University; R. E. Hage is senior engineer in the preliminary-design department at Boeing Airplane Co. A contribution to modern plane-design literature in the best engineering sense.

Air Transportation. By G. Lloyd Wilson and Leslie A. Bryan. 665 pp; illus; index; (pocket map). $7.65.—Written by two professors, respectively at the Universities of Pennsylvania and Illinois, and based on various texts used during recent years in undergraduate and graduate courses. The subject is covered in an exceedingly broad fashion, treatment ranging from Elijah and Icarus to Piasecki; but the book is a large one and manages to embrace between its covers a vast quantity of relevant detailed information. The three major sections present *(1)* the general background of aviation; *(2)* an account of commercial air transport; and *(3)* a study of air-transport regulation. Each of the 34 chapters is followed by a list of selected bibliographical references. Should be useful as a general text, and especially so for college requirements.

An Introduction to the Mechanics of Viscous Flow. By H. F. Purday 185 pp; diagrams; index. $2.50.—Designed to fill the gap requiring an elementary adequate textbook on the application of modern fluid dynamics to problems of lubrication and heat transfer. The author is chief designer of the high-speed Diesel engineering department of Harland & Wolff, Ltd. This is the first American edition of the book published in England under the title *Streamline Flow.*

Traffic Management Manual No. 31: Air Freight Transportation. By Richard Malkin. 105 pp; illus. $1.50.—Described as "the first textbook published devoted entirely and exclusively to airfreight transportation," which may be a trifle discriminatory against *Air Cargo; Inside Story of a New Business,* by Eric Rath and G. L. Knight, published in 1947, (but not too much so, because it is so very much more comprehensive and detailed than that other very sketchy treatment of an important subject.) The present coverage is of organization, service, rates and regulation, and it is done with straightforwardness, authority and economy of words, befitting the introductory nature of the work. Richard Malkin is managing editor of *Air Transportation Magazine,* and his associates in production are members of the traffic research staff of La Salle Extension University. A very worthwhile and creditable job within its purpose limits.

Learning to Fly. By Bert A. Shields. 262 pp; illus; index. $4.—An unusually explicit manual for the student pilot, filled with many observations arising from conscious experience. These extras come, of course,

Use this coupon for ordering books

AERO DIGEST Book Department
515 Madison Ave., New York 22, N. Y.

I am enclosing check (or money order) for the following book(s), to be sent shipping charges prepaid.

Title ..... Title .....

Author ..... Author .....

Price $ ..... Price $ .....

My Name .....

Address .....

City ..... State .....

NO RADIO NOISE!

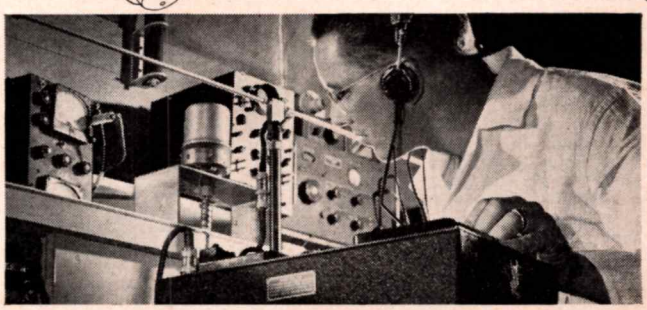
One of the basic problems in manufacturing actuators for aircraft is to keep their tiny high speed motors from broadcasting "hash"... unintelligible noise... into the pilot's radio receivers.

At AiResearch this problem is being whipped. First, a noise filter is specifically designed into each type of actuator we build, and over the years we have succeeded in making these smaller and smaller while getting more and more efficiency out of them.

Then, as a routine manufacturing procedure, each actuator is tested for silence in our own radio noise laboratory—the most complete privately owned lab of its kind.

This is another example of the ability of AiResearch to design and manufacture specialized equipment for hard-to-do jobs. It indicates why nearly every type of high-altitude and jet aircraft produced in the U.S. carries AiResearch equipment.

AiResearch
DIVISION OF
THE GARRETT CORPORATION



RADIO NOISE LABORATORY at AiResearch. In this copper-lined vault all AiResearch equipment is thoroughly tested to make sure it meets specifications for freedom from radio noise.

• Whatever your field — AiResearch engineers — designers and manufacturers of rotors operating in excess of 100,000 rpm — invite your toughest problems involving high speed wheels. Specialized experience also available on compact turbines and compressors; actuators with high speed rotors; air, gas and liquid heat exchangers; air pressure, temperature and other automatic controls.

An inquiry on your company letterhead will receive prompt attention. AiResearch Manufacturing Company, Los Angeles 45, California.

—MORE NEW BOOKS

from Lt. Shields "who has operated more than 25 different types of airplanes and has more than 5000 hours flying time to his credit." He was a flight instructor in both World Wars, has managed an airport and a flying club, and has headed a 35-instructor group addressing 1000 aeronautical students. His present text is not merely a fly-it-yourself guide, but an excellent book for inclusion in the curricula of formal flying schools.

National Air-Race Sketchbook, 1930 to 1949. By Fred W. Buehl and Harry S. Gann. 84 pp; illus. $2.—Meets a need for a history of the National Air Races, providing statistics, pictures and a running account of the event for each year. The authors are aviation engineering students at the University of Southern California. A foreword has been provided by Tony LeVier, president of the Professional Racing Pilots' Association.

Peace on Earth. 251 pp; appendices $3.—Twelve distinguished persons, including Trygve Lie, Herbert Evatt, Eleanor Roosevelt and Ralph Bunche, have banded to discuss, under this title, factors — mainly those represented in the United Nations—which are calculated to better the human race. The three appendices comprise the charter of the United Nations; the statute of the International Court of Justice; and the Declaration of Human Rights. Robert E. Sherwood has written the introduction. This is all information that has been available for a long time in the daily press, rehashed and reinterpreted in the magazines; but to have it concentrated in one place by competent hands brings it into perspective and provides a result that must be distinctly useful.

Radio Technology. By Ernest J. Vogt. 573 pp. $6.—It is significant to learn on the title page that the author is consulting radio engineer to Aerojet Engineering Corp. Therefore, in writing his book, he must have had the needs of aeronautical people at the back of his mind —at least those of serious students. He will recall to the aeronautical engineer those portions of electrical theory which he once studied in college and has since forgotten: Radio Mathematics; Direct Current Theory; Alternating Current Theory; the Vacuum Tube and Oscillator. Then Vogt deals in simple but sound fashion with Receiving-Circuit and Transmitting-Circuit Principles. There is a splendid chapter on Antennas and on Radio Aids to Navigation. Since instrument flying and landing is vital to aviation, engineers, pilots and operators will all find this book worthwhile, serious reading.

The Autobiography of Will Rogers. Edited by Donald Day. 410 pp; frontispiece; index. $3. —A skilful piecing together of day-to-day writings by the beloved cowboy humorist, giving not only a satisfactory picture of his well-rounded life but also a virtual treasury of his witticisms. America never has had a truer personality than Will Rogers, and the aviation industry never had a truer friend. The bulk of the material used here comes from Rogers articles in the *Saturday Evening Post* and from his syndicated newspaper column which he conducted from 1922 until his death in 1935.

To the Moon and Halfway Back. By Roger Q. Williams. 292 pp; illus. $6.—The holder of Pilot License No. 300 tells the story of aviation in an exciting recounting of his own life experience from 1910, when he took his first airplane ride at Sheepshead Bay, New York—through his stunt-pilot and barnstorming days, through his aircraft-manufacturing, teaching and lecturing phases, through his period as a transatlantic pioneer — to his present time of fascinating speculation concerning the future of human flight. He tells all this modestly and with an active imagination that makes for delightful reading augmented by a wealth of unusual photographs. *To the Moon and Halfway Back* should be in every library that purports to serve the reader who has the aeronautical turn of mind.

Weld Design. By Harry D. Churchill and John B. Austin. 216 pp; illus; diagrams; bibliography; index; appendix. $6.65. — Intended to supply a definite need for a concise text on welded machine-base design. Since electric arc welding has been recognized only recently by the machine designer, many engineers have been unaware of the advances in fabricating machine bases by this process. The authors treat the subject from both the practical and theoretical standpoints, affording the designer a thorough understanding of the materials that enter into machine-base construction, and a clear picture of the many methods of processing plates and structural shapes, the amount and type of welding that go into the structure. Recommended by the James F. Lincoln Arc Welding Foundation Award Jury.

The Story of Magnesium. By W. H. Gross. 262 pp; illus; glossary. $2.—Published by the American Society of Metals as one of their *Techbook* Series For Self-Education, this volume was designed for the layman rather than the scientific or technical specialist. While written by a metallurgist, the text has been reader-tested by high-school students and is in the educational range of industrial workers with no professional or technical training. It covers the history of magnesium and its amazing expansion, of the methods of making this metal from rocks, brines and sea water, of the properties of the metal and its alloys, and of the process whereby the metal, in ingot form, can be converted into fabricated materials.

Engineering Materials and Processes. By W. Howard Clapp and Donald S. Clark. 518 pp; illus; charts and diagrams; index. $6.50. — Second edition, treating of the physical properties and uses of the principal engineering materials; metals and plastics; including a description of methods by which these are processed. Changes have been made in chapters dealing with cooling curves and equilibrium diagrams, plastics, castings and joining of metals. New basic processes have been included in most of the chapters. First edition was published in 1938.

Airplane Design. By Karl D. Wood, 376 pp; illus; bibliography; index. $6.—Ninth edition of a textbook on preliminary aircraft design and layout by the head of the department of aeronautical engineering of the University of Colorado. Profusely illustrated with offset photos, charts, tables and diagrams, the volume includes latest information on developments in jet propulsion, low drag and high lift. This new edition has been written in accordance with the new provisions of CAR 3, promulgated in 1947, which relate to airplane design.

Caste System in the American Army. By John J. Lenney. 233 pp; bibliography; reference notes; appendix. $3.—A study of the Corps of Engineers and their West Point "system" during the period 1775-1925, written by a former Regular combat veteran and Washington attorney. From 1914 to 1926, the author did research on his Ph.D. thesis "Promotion from the Ranks in the Regular Army," and his information thus acquired has been twice printed as a public document by the U. S. Government. It is now in the custody of the National Archives at Washington. This present book is based on that research. It traces the influence left by the Corps of Engineers on West Point and the Regular Army by its 65-year tenure in charge of the Point. The West Point "system" is charged with being undemocratic and inhumane and a question is raised as to whether it is essential to our national security. The author outlines concrete remedies in keeping with democratic ideals, including a new plan of admission requirements to the celebrated military academy.

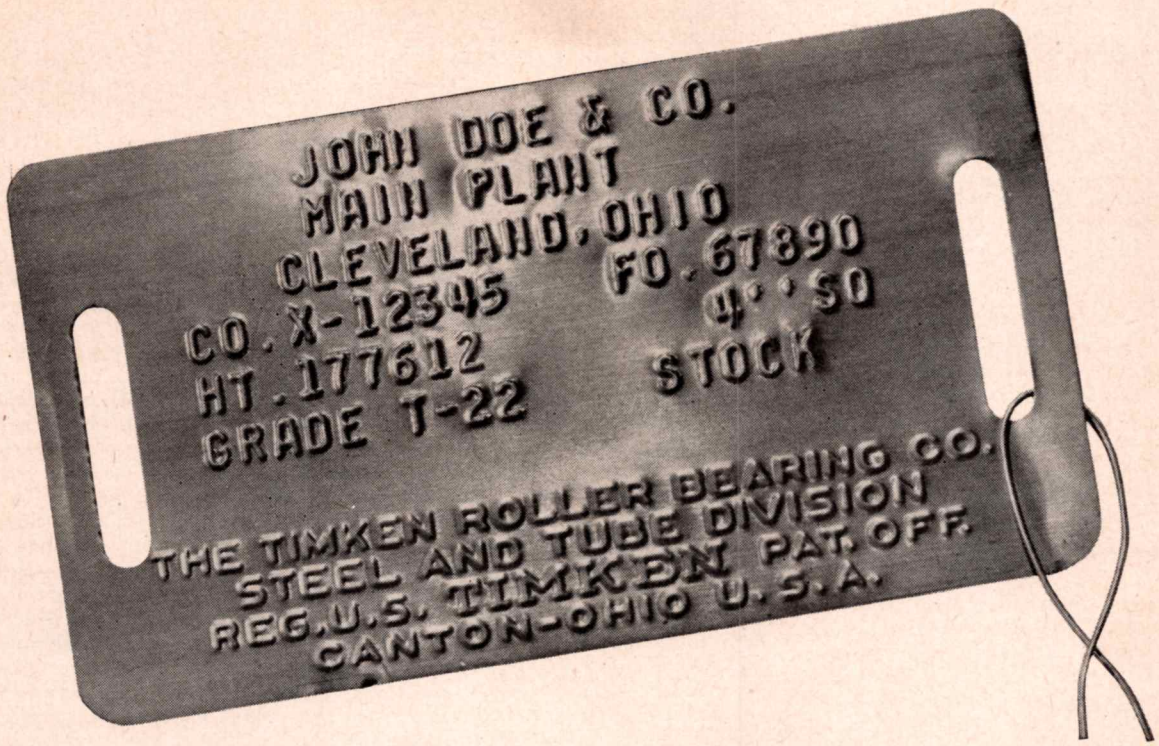
Conveyors and Related Equipment, 2nd Edition. By Wilbur G. Hudson. 468 pp; illus; tables; charts; appendix; index. $7.—A comprehensive coverage of the science of materials handling, describing the use of all types of conveyors. Besides reporting on different types of equipment, they are analyzed from the standpoint of how well they will deliver the goods under various applications. Additions in this revised printing include extended discussions on pneumatic conveying, dust-explosion hazards, recent technical improvements in belt conveyors and the applications of motorized industrial trucks. The author is a mechanical-engineering graduate of Cornell University, a member of ASME and has had over 35 years engineering experience in the specialized field of which he writes.

Machinery's Handbook, 14th Edition. By Erik Oberg and F. D. Jones. 1911 pp; charts, tables and diagrams; index. $7.—Reference volume containing basic information, data and formulae for use in either designing or building any type of machine or other mechanical device. A feature of this edition is the new, Unified and American Standard Screw Thread System, by which threads are interchangeable in the U. S., Canada and Great Britain. The sections on broach design and roller chains have been revised, as has the section on worm-gearing. Several new sections have been added, including one on electric motors and another on carbide tools. Material has been selected to be of greatest use to largest number of designers and manufacturers of mechanical products.

Principles of Aircraft Propulsion Machinery. By Israel Katz. 477 pp; illus; charts and diagrams; bibliography; index. $6.50.—An elementary engineering text which presents the fundamental aspects and nature of aircraft-propulsion machinery and helps to evaluate the worth of existing equipment in the light of historical data and current developments. The volume is divided into eight parts: Orientation, Development, Fundamental Aspects, Performance, Piston Engines, Gas Turbines, Advanced Powerplants (Rockets) and Application. Author is in charge of the Cornell University Aircraft Powerplants Laboratory and has taught at Pratt & Whitney Aircraft.

The 1950 Information Please Almanac. Edited by John Kiernan. 927 pp; maps; index. $2.50.—The 4th issue of what has come to be one of the nation's handiest sources of dependable information, and what is coming to be one of the most necessary for gaining perspective on these increasingly complex times. In addition to the usual admirable summaries, digests and statistical tables prepared by authoritative hands, there is featured a "Vacation Travel Guide for the United States and the World," including probable costs per trip. A complimentary word is in order for the excellent job of printing, which is crisp, clean and exceptionally readable for a compilation in small type.

Easy way to make sure of uniformity in your stainless steel forging bars



WHEN you see this shipping tag on the stainless steel forging bars you buy, you know you're getting uniform, high quality.

Timken® stainless steel forging bars have superior surface and internal quality. Each analysis has uniform forgeability, uniform physical and chemical properties, and uniform response to heat treatment—from bar to bar and from heat to heat.

As a result, you get uniform, high quality in your finished forgings—and get it at lower cost through fewer delays, fewer rejects and fewer changes in shop practice.

That shipping tag is backed by The Timken Roller Bearing Company's complete, rigid quality control through every step of manufacture. By special Timken Company mill practices. By years of leadership in alloy steel research.

Ask for an "on-the-job" analysis by our Technical Staff. No obligation. And write for our authoritative booklet, "Evaluating the Forgeability of Steels". The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH

TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
Fine Alloy
STEEL
and Seamless Tubes

Specialists in alloy steel—including hot rolled and cold finished alloy steel bars—a complete range of stainless, graphitic and standard tool analyses—and alloy and stainless seamless steel tubing

for fiscal 1950. Air Force items in this category are cut from $213 million to $207 million. Air Force guided missile procurement is given $17 million, compared with $16 million in the current fiscal year.

National Advisory Committee for Aeronautics gets a modest increase from $43 million to $46 million. Its funds for construction and equipment are raised from $10 million to $16.5 million.

Appropriations for Air Reserve and Guard elements, on which reliance for mobilization would have to be placed, are cut slightly, except that Air ROTC gets a moderate raise.

Air Force Reservists on drill-pay status for fiscal 1951, according to the budget estimate, are to be only 118,000, compared with 605,000 for the Army and 256,000 for the Navy. Air National Guard will have 49,500 on training pay. Air Reserve is still a weak spot.

Defense Secretary Johnson, however, recently recognized the importance of the Reserves generally by ordering that each Regular officer, at some time in his career, would have to put in two years as a Reserve instructor.

Civil-Aviation Increase

Civil Aeronautics Administration is slated for a substantial increase, from $143 million to $212 million. Its contract authority is budgeted at $70 million for fiscal 1951, compared with $67 million in the current year.

Civil Aeronautics Board is up for a raise from $3.7 million to $4.3 million, after complaining that its staff is less while its work load is much more than in prior years.

Establishment of air-navigation facilities, as the RCTA program progresses, will get $40.5 million as compared with $18.6 million. Funds for maintenance of facilities also are increased. Air-navigation development is raised from $7 million to $9.9 million.

The national airport program appropriation is $51.3 million, as compared with $14.5 in the current year. But the difference, as in the Air Force funds, is mostly to cover obligations incurred from past authority.

Funds for other civil aviation proposed, including GI flight-training and carrying of the air mail, are included in routine appropriation estimates.

Legislation

In the early weeks of the session, there is not much to report beyond our December summary of pending legislation and further notes in January. Bills left incomplete in the first session retain their status and may proceed if there is any steam behind them.

Transport-plane prototype legislation is one of the most important results to be hoped from the second session. The ban against use of military funds for commercial-type planes, as written into HR 1437, the Air Force composition bill, remains to be clarified as conferees adjust House and Senate differences.

Now that the industry has agreed not to oppose prototype aid, the question of whether to work through Air Force or CAA remains. Whatever is done in HR 1437, another bill regarding prototypes is thought likely before adjournment. The latest enactment, of course, will supersede anything that went before. Then jet-transport plans may proceed.

Economy will cast its shadow on legislative proposals as well as appropriations. There is no little opposition to the Air Force Academy, not yet authorized by Congress, although the Air Force is looking for a site. Whether the air-engineering center authorized this past year really will proceed is still thought among Washington observers not to be sure.

Question of air-mail subsidy separation, on which the airlines have taken a neutral position, awaits reporting of a private study to the Senate Interstate Commerce Committee early in February. Not much chance is held for the super-transportation agency in the Commerce Department this year, although some features may be offered.

Air safety will be a subject of House hearings which may influence CAA and CAB action, whether or not an independent safety board or director is voted. A lot here depends on chance, whether or not there are more crashes soon. Otherwise, most legislation depends upon hard work, pro or con, a point worth remembering.

CYBERNETICS AND AVIATION MEDICINE

(Continued from page 33)

when compared with human consumption under similar conditions. Energy sources for activation of the instruments and devices will be present in energizing devices for propulsion. Oxygen may be used as propellant and, if it is, will be present in great quantity for use of either the human or machine (or device).

High degrees of barometric pressure change—from 760 *mm H g* at sea level to 0 *mm Hg* in the hard vacuum of space—as far as the human is concerned, will necessitate pressurization of his immediate environment under precise automatice control. Possible variations of pressure because of leaks or penetration of meteor particles had best be left to automatic control is so far as it is possible to do so. High degrees of barometric pressure change will affect those devices dependant upon pressure for activation. However, the mechanical and electronic problems coincident with barometric-pressure change are indeed small when compared with the human problems.

Again, high degrees of temperature change, of the order of 647°*C*[4] which have been measured in the skin of the V-2 rockets, produce serious insulating and cooling problems for the human but relatively inconsequential problems for mechanical- and electronic-control devices.

Linear and tangential acceleration and deceleration certainly will affect crew and passenger personnel much more than control mechanisms.

Cosmic and ultraviolet radiation is undoubtedly of sufficient intensity in superterrestrial space to afford a rather serious human problem; but, again, it is a relatively small problem as far as control mechanisms are concerned.

We now arrive at a physiological and psychological limitation which represents a very serious obstacle—that of the comparative slowness of human perception. It is difficult to hazard an intelligent guess as to the speeds which will be attained in future travel. Speed, *per se*, as we all know, is unimportant physiologically or psychologically. As a matter of fact, we are now turning with the earth at approximately .289 *mi*/sec.[5] at the equator; at the same time we are moving in an orbit around the sun at a speed near the order of 18.50 *mi*/sec;[5] again we are rotating with our galaxy at a speed probably of the order of 170 miles per second. These movements are imperceptible to us in our everyday life. They become perceptible only when acceleration or deceleration becomes a factor.

However, relative speed becomes a very serious limitation both physiologically and psychologically when our movement is considered in relation to a motion or lack of motion of objects which is in variance with that of ourselves. Let us consider for a moment the hypothetical minimum break-away speed which, according to our physicists must be attained in order to leave the gravitational influence of our earth and thus become a carrier capable of space travel. This speed is probably of the magnitude of 7 miles per second or about 25,000 miles per hour. Human reaction time for the most simple reflex activity, that of two neurones connected by a synapse, is about two-tenths of a second. It is considerably longer for more complex types of activity. This time period is dependent upon and limited by the speed of transmission of impulses through nervous tissue, which to date can be altered practically not at all.

There are also other time factors which must be added to that of basic reaction time. These are the time intervals involved in perception, discrimination and decision. They may add tenths of seconds to entire seconds to the total reaction-time factor. To translate the final product of human reaction into something which will alter course, speed, or some such function as cabin pressure of an aircraft, usually involves an additional time lag—the reaction time of airfoils or other structures necessary to produce the desired effect. This time lag also may be of the order of tenths of seconds to seconds.

Let us again turn to the break-away speed of seven miles per second. From the standpoint of visual perception, the unaided eye is unable to perceive anything but very gross objects at a distance of seven miles and then only when vision is entirely unobstructed by such factors as darkness. It is doubtful if a pilot, regardless of his physical and psychological endowments, would be capable of useful direction in situations which encompass such speeds. However, the problem is not insoluble from the theoretical standpoint when radar-type of perception is coupled directly through tracking and predicting mechanisms with the controls. It must be remembered that the reaction time of such mechanisms is only a small fraction of that of the human.

Now, on the surface, all of this may appear to be highly imaginative and to represent the same type of difficulties which were predicted a few years ago when aircraft speeds of 400, 500 or 600 *mph* were contemplated, but which were solved, so to

(Continued on page 84)

AMERICAN TIGER BRAND CONTROL CABLES used in the Boeing Stratocruiser were selected because of their proved reliability on hundreds of other Boeing planes.

New Boeing Stratocruiser

EQUIPPED WITH AMERICAN TIGER BRAND CONTROL CABLES

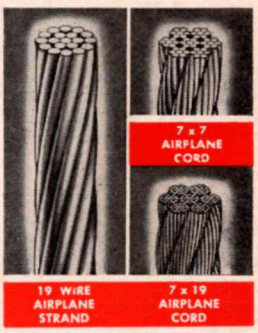
THE Stratocruiser is a 67½ ton, four engine, double-deck plane embodying new ideas in luxury and comfort. It can carry 114 passengers, cruise at 340 mph., and has an operating altitude of 25,000 feet. The C.A.A. has certified this ship for an operating load of 142,500 pounds.

The Stratocruiser takes full advantage of wartime aeronautical developments including the best in aircraft control cables. American TIGER BRAND Cables won their reputation on the B-29 Superfortress, C-97 military transport, the Consolidated Vultee B-36, and numerous other famous planes.

TIGER BRAND Control Cables are designed and engineered to give safe reliable service even at the extremely low temperatures encountered at high altitudes. They are of Excellay Preformed construction. This means they work easily over the pulleys, are flexible, and have high resistance to fatigue and abrasive wear. Stretch has been reduced to a minimum.

For complete information on American TIGER BRAND Control Cables, write for our "Manual of Aircraft Materials." This 260-page book covers all aircraft materials produced by American Steel & Wire Company.

AMERICAN STEEL & WIRE COMPANY
GENERAL OFFICES: CLEVELAND, OHIO
COLUMBIA STEEL COMPANY, SAN FRANCISCO
TENNESSEE COAL, IRON & RAILROAD COMPANY, BIRMINGHAM, SOUTHERN DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK



AMERICAN TIGER BRAND CONTROL CABLES

USS

UNITED STATES STEEL

CYLINDRICAL ACCUMULATOR DEVELOPMENT

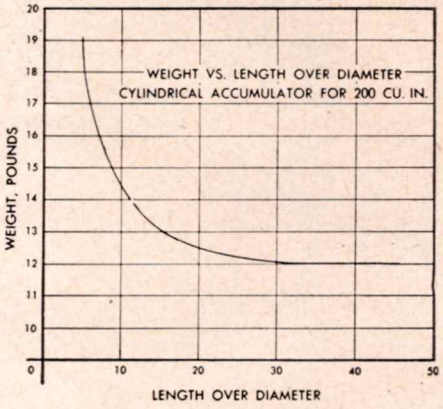
Recent advancements in 3000 psi hydraulic systems have resulted in compact hydraulic systems of low capacity handling extremely high horse power. 3000 psi accumulators under development and manufacture for the past 7 years have not as yet been able to meet all requirements of USAF and USN specifications for these devices. Up to now service troubles have been negligible but the more severe operating conditions have caused an out-cropping of accumulator troubles in these particular airplanes.

Approximately a year ago the Pacific Division of Bendix Aviation Corporation, faced with the necessity of overcoming this problem, turned to the cylindrical type of accumulator which was abandoned early in the war. A thorough, concentrated development program carried on during the past year has filtered out the difficulties associated with the earlier cylindrical accumulators with the result that they now have available cylindrical accumulators which have met all requirements of specification AN-A-3.

PRICE AND WEIGHT ADVANTAGES

Not only do these accumulators satisfactorily pass all prescribed tests but they meet the weights of the spherical accumulators and are available at a cost considerably below that of the spherical type. Most interesting single phase of the development program is the physical shape of the accumulator. The use of a greater length/diameter ratio has resulted in a minimum of lost weight in the cylinder ends and pistons and at the same time has eliminated problems associated with breathing and allied sealing ring problems.

Pictured below is a chart which shows the weight for a given displacement accumulator as designed with various length diameter ratios.



Also of interest is the fact that where numerous accumulators are required in one airplane, stops can be built into the cylinder to limit the travel of the piston. Requirements for hydraulic systems call for adequate reservoir capacity to permit normal functioning if the accumulators lose their precharge. Large accumulator capacity, therefore, calls for high reservoir capacity but a simple stop in the accumulator to limit the piston travel will save an equivalent volume of oil, thus representing an additional weight saving. The small diameter has resulted in exceptional gunfire characteristics. The use of the same specification steel and same heat treatment used on Bendix-Pacific spherical accumulators, of which more than 70,000 have been built, has simplified this development problem.

LOST AIR CHARGE ELIMINATED

New style restrained shear rings in the end cap have further contributed to the light weight of the accumulator. The floating piston and seal arrangement designed by Bendix-Pacific has resulted in a minimum chance of lost air charge. In all tests to date only one case of air loss has been experienced and that was directly traceable to a faulty "O" ring. This air loss occurred only at the 0 to 3000 psi cycling test and despite the improper "O" ring no loss of air was experienced at normal operating ranges.

Anticipating an immediate demand for this type of accumulator, the Pacific Division is taking steps to set up high volume production machinery thus contributing to the low price of the cylindrical accumulators.

For —65°F operations and other specialized applications

Concentrated engineering development at Bendix-Pacific over the past year has perfected these piston-type Cylindrical Accumulators for specialized applications. They are now in regular production. Among applications for which they are being specified are those requiring —65°F operations, where high precharges and fast discharges must be handled, and where high operating temperatures are generated by rapid flows in restricted systems. These Accumulators have been designed to meet the three AN sizes and have been thoroughly tested under all requirements of AN-A-3B. Flexibility of design permits adaptations to meet any reasonable displacement. Weights compare most favorably with spherical types while prices are considerably less.

For complete information and engineering assistance write—

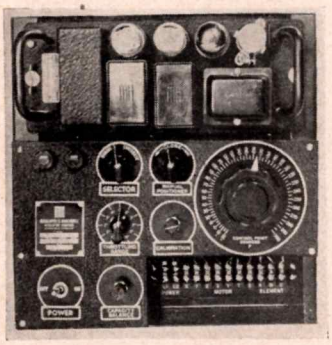
PRODUCT OF Bendix AVIATION CORPORATION

Pacific Division
Bendix Aviation Corporation
NORTH HOLLYWOOD, CALIF

East Coast Office: 475 Fifth Ave., New York 17 • Canadian Distrib.: Aviation Electric Ltd., Montreal
Export Division: Bendix International, 72 Fifth Ave., New York 11, N.Y.

AERO EQUIPMENT and TRADE LITERATURE DIGEST

A vital information Service for the convenience of qualified personnel in the aeronautical industry. Additional information on the items in AERO EQUIPMENT AND TRADE LITERATURE DIGEST may be had by filling in coupon at left, clipping it to your company letterhead — and mailing it to AERO DIGEST.



Temperature Controller

B-2

New, low-cost, highly sensitive electronic temperature controller with range from —20° to 300°*F*. Can be operated manually or automatically and has a throttling range of 0—10°.

Brown Instruments Div.
Minneapolis-Honeywell Regulator Co.
Wayne & Roberts Aves.
Philadelphia 44, Pa.

Asbestos Sheet Packing

B-4

New *Palmetto* compressed asbestos sheet packing developed to ANA Spec. AN-G-171, Class 1. Design combines resistance to heat, oil and solvents with particular resistance to alcohol-water and ethylene glycol-water solutions. Also resistant to such refrigerants as freon. Available in gasket form to specification.

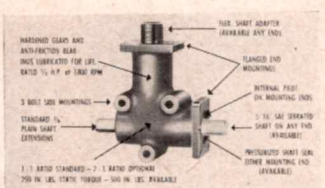
Greene, Tweed & Co.
342 Elm Ave.
North Wales, Pa.

Synchronous Camera

B-5

16-*mm* cameras originally designed for service flight testing may be operated at ambient temperatures of from —50° to 110°*F*. and at altitudes up to 40,000 *ft*. Can be used for photographing at two or more remote stations with exact shutter synchronization. One model has shutter speeds of 5-20 *fps*, another from 4-32 *fps*.

Flight Research Engineering Corp.
Richmond 1, Va.

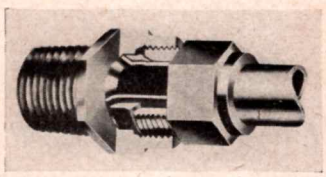


Universal Angle Gear

B-3

Improved *ANGLgear* right-angle gear unit, redesigned for universal mounting. Incorporates two 4-bolt side mountings at shaft takeoff points in addition to original 3-bolt side mounting, permitting unit to be mounted in three ways. Bearing retainers on flange-mounting ends have been recessed so that internal pilot feature is obtained. Available in 2:1 or 1:1 ratios.

Airborne Accessories Corp.
25 Montgomery St.
Hillside 5, N. J.



Aluminum Tube Fittings

B-1

Same *Uniflare* design as firm's brass fittings, they are anodized for corrosion-resistance and may be re-assembled many times without impairing seat tightness. Features include self-flaring, leakproof seal and use with standard wall tubing.

Scoville Manufacturing Co.
Waterbury, Conn.

Portable Mixing Motor

B-30

Air-powered mixing motor for use in agitating plating solutions, oil and water quench and in preparing drawing compounds. Mixing motor can be clamped on edge of any mixing vessel and adjusted to any angle. Five power units are available, from 500-17,000 *rpm*.

The Aro Equipment Corp.
Bryan, Ohio

Levelimeter Instruments

B-31

Illustrated catalog of 24 pages describing instruments that indicate, measure and control liquid level and inter-face level. Variations in liquid level in weirs and flumes are utilized for measurement and control of large flow rates. Illustrated and described are such instruments as magnetic tape-and-drum, electronically transmitting and pneumatic instruments, flowmeters and sight gage glasses.

Fischer and Porter Co.
Hatboro, Pa.

(Continued on following page)

Write number of item here [ ]

Name .....

Company .....

Address .....

.....Title .....

AERO DIGEST, New York February, 1950

Write number of item here [ ]

Name .....

Company .....

Address .....

.....Title .....

AERO DIGEST, New York February, 1950

Write number of item here [ ]

Name .....

Company .....

Address .....

.....Title .....

AERO DIGEST, New York February, 1950

Announces

A series will appear in this column to inform our many friends of the accomplishments and problems solved for the industry by Lavelle during the post-war years. Lavelle is ready and interested to know of your production and manufacturing problems, and welcomes inquiries to bid on your work.

A Unique sub-contractor

EXPERT FABRICATORS OF METAL AIRCRAFT PARTS

Lavelle

AIRCRAFT CORPORATION

NEWTOWN, Bucks County, PENNA.

(Continued from preceding page)

Titanium Tubing

B-10

Welded, cold-drawn titanium tubing is available in three standard tempers: annealed, half-hard and hard-drawn, in sizes from ¾-*in* by .049-*in* wall to ⅛-*in* by .010-*in* wall. Heavier wall thicknesses in *Weldrawn* tubing and a line of seamless tubing available shortly.

Superior Tube Co.
Norristown, Pa.

Oil Cooler-Cleaner

B-11

Designed to circulate chemical cleaner and remove dirt from oil-temperature regulators, it is powered by 2-*hp* motor, driving a 20-*gpm* pump providing pressures to 80 *psi*. Manually-operated 4-way valve allows reversible flow to flush and clean coolers.

Pacific Airmotive Corp.
2940 N. Hollywood Way
Burbank, Calif.

Paint Striper

B-7

Gravity-feed paint striper has no engine compressor or pump and features a brushless, sled-type paint spreader that can accommodate any standard striping or zone paint. Spreaders are interchangeable and are available in widths from 2-8 *in*. Standard model equipped with 9-*gal* tank, another with 5-*gal* tank.

Universal Marine & Mfg. Corp.
137 Alexander St.
Yonkers 2, N. Y.

Prop Governor Ice Guard

B-16

Stainless-steel ice guard for DC-4 and C-54 aircraft with all parts fully interchangeable. Low initial cost, negligible maintenance. Now being used by airlines.

Skyline Products, Inc.
92-26 180th St.
Jamaica, L. I., N. Y.

Snow-Plow Chute

B-17

New loading and casting chute for Bros rotary snow plows, which revolves 270° from side to side and can be telescoped to cast snow in any position in the 270° arc.

Wm. Bros Boiler & Mfg. Co.
Minneapolis, Minn.

Remote VHF Receiver

B-18

Supplementing the VHF *Omnimatic* system of navigation, and other equipment, this new remotely controlled VHF receiver with small cockpit tuning-control unit is available for aircraft requiring flexible-mounting arrangements. Features continuous tuning for all VHF tower, range and VOR reception facilities.

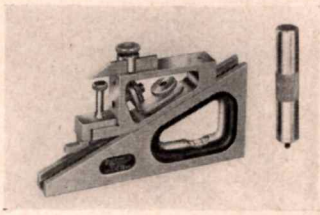
Lear, Inc.
110 Ionia Ave. N.W.
Grand Rapids 2, Mich.

Metal Fabricator

B-9

Metal-working machine with rapid interchangeability for punching, notching, nibbling and slotting. Quick-change holder permits changing of punches and dies in seconds with perfect alignment. Full-floating driveshaft places ram load directly on frame, eliminating bending stress on driveshaft.

Wales Strippit Corp.
345 Payne Ave.
North Tonawanda, N. Y.

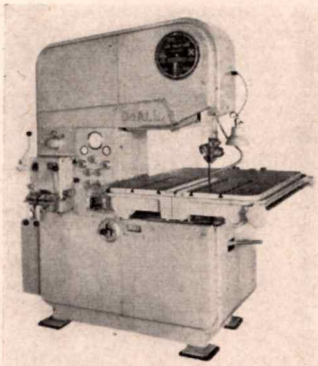


Universal Precision Gage

B-6

Specifically designed for inspectors, machinists, gage, tool and die makers, this precision gage can be adjusted quickly and easily by a thumbscrew to the exact size wanted from a micrometer, height gage, calipers or gage blocks. Scribing and foot attachments permit its use as a surface or height gage or setting ⅛ *in* below base line. Innumerable practical applications.

The L. S. Starrett Co.
Athol, Mass.



Contour Saw

B-12

Providing fast precision cutting of any material, performed through a repetitive production cycle, easily controlled by operator. Has speed range of 40-10,000 *fpm*. Hydraulic operation throughout. Has 16-*in* stroke at work table and 12-*in* stroke at saw table, which tilts 45° right and 10° left. *Contour-matic* is claimed to be first major improvement to a basic machine tool in 10 years.

The DoAll Co.
Des Plaines, Ill.

(Continued on page 80)

MEN AT WORK ON

Lighter, Smaller Packages of Power!

How our people work out new ideas that make airplane accessories *smaller* and *lighter* isn't in this photograph.

You don't see, for instance, the plain horse-sense going into those designs, and the sacred cows that don't. You don't see the man-hours of development and testing it takes to give you *exactly* what you want.

Experience and a pioneering-minded attitude just can't be photographed. But they are the *real* reasons why you can *depend* on Jack & Heintz to develop . . . prove . . . and deliver lighter, smaller packages of power!

J&H

JACK & HEINTZ

PRECISION INDUSTRIES, INC.
CLEVELAND 1, OHIO

Specialists in ELECTRICAL WAYS AND MEANS for aircraft

ACTUATORS | GENERATORS | STARTERS | INVERTERS | AIRCRAFT MOTORS | AUXILIARY POWER UNITS | ELECTRICAL SYSTEMS AND CONTROLS

CLEAR COMMUNICATION OMNI NAVIGATION

WITH A.R.C. VHF EQUIPMENT

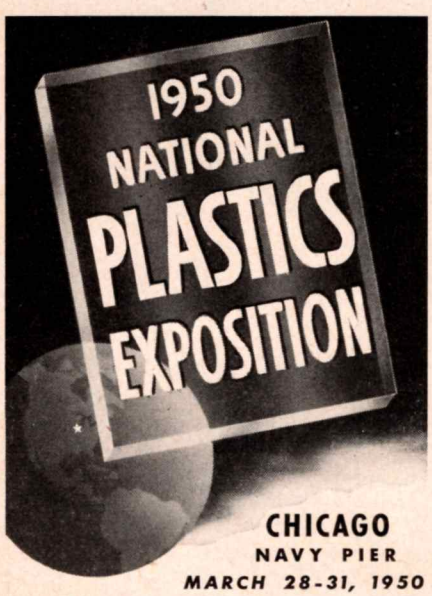
Fly Directly in Less Time— Keep All Signals

STATIC FREE!

Get static-free communication and the added reliability of omni range navigation by installing A.R.C.'s Type 17 2-way VHF Communication and Type 15B Omni Range Navigation Equipment. With the 15B tuned to the VHF omni stations now covering the country, you fly directly in less time. You can receive weather broadcasts simultaneously with the navigation signals—*static free!* The 15B takes the work out of navigation and provides long, trouble-free life. The Type 17 provides an independent communication system for use while the 15B is busy providing navigational information. Other A.R.C. equipment provides LF range and broadcast reception, and rotatable loop navigation.

All A.R.C. Airborne equipment is Type Certificated by CAA. It is designed for reliability and performance — not to meet a price. Installations for both single and multi-engined planes are made only by authorized service agencies. Write for further details or name of your nearest A.R.C. representative.

Aircraft Radio Corporation
BOONTON, NEW JERSEY



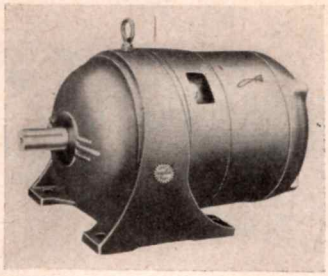
CHICAGO
NAVY PIER
MARCH 28-31, 1950

For designers, production men, sales executives, merchandise men and buyers in all industries and businesses. See all the latest advances in the world of plastics. See how to use plastics in all forms, old and new — to stimulate the sale of *your* products. Over 100 exhibits — materials, machines, finished products. Consult with the experts—they'll be there!

Guest Tickets: Exposition not open to public. Free guest tickets are available by writing (on your company letterhead) to

THE SOCIETY OF THE PLASTICS INDUSTRY
295 MADISON AVENUE, NEW YORK 17, N. Y.

(Continued from page 78)



Gearmotors

B-8

New gearmotor, manufactured in 17 sizes, provides single, double and triple reduction units having output speeds from 780-7½ *rpm*. Integral *hp* ratings from 1 through 75 *hp* are available for any industrial application. Manufacturer listed below has announced joint manufacture of the line with the Louis Allis Co. of Milwaukee, Wis., and makes available *a-c* and *d-c* motors of all types including those with special electric characteristics.

Foote Bros. Gear and Machine Corp.
Chicago, Ill.

Gate Valve

B-14

Small, lightweight gate valve for 75-*psi* aircraft fuel-system service, can be used also for high temperature air, oil, water-alcohol mixtures and other fluids. Produced in three sizes, 1¼ *in*, 1½ *in* and 2 *in*, valves are of welded-alloy aluminum body halves and utilize line pressure for sealing.

The Parker Appliance Co.
17325 Euclid Ave.
Cleveland 12, Ohio

Fractional HP Motor

B-15

High-speed, reversible, 1/100-*hp* *d-c* motor, with built-in mechanical brake. Designed for rotary or linear actuation where extreme precision of movement is needed and motor must be stopped from top speed in minimum number of revolutions. Running torque is 1.1 *in oz* at 19,900 *rpm* at 28 *v* *d-c*; brake operates within range of 18-30 *v*.

Elecro-Aire, Inc.
11439 Vanowen St.
North Hollywood, Calif.

Mobile Air Compressor

B-13

Trailer-mounted mobile compressors designed for operating small air tools such as spray guns, chipping hammers, paving breakers, spaders and tampers. Air-cooled with V-belt drive to a gas engine, they are available in three sizes and balanced for one-man handling, as well as towing.

Gardner-Denver Co.
Quincy, Ill.

TRADE LITERATURE

See Instructions on Page 77 for Obtaining Additional Information

High-Intensity Runway Light

B-20

Bulletin describing construction and application of fixed-focus, high-intensity runway marker light, approved under CAA Spec. L-819. Also includes bills of material, schematic and wiring diagrams for multiple and series circuits, complete ordering information and illustrations of all equipment for each system.

Line Material Co.
Milwaukee 1, Wis.

Centrifugal Chemical Pumps

B-21

Bulletin describing and illustrating equipment used in chemical-process industries, giving complete explanation of the *Mechanical Seal* especially designed to prevent leakages of corrosive liquids and describing *Worthite*, a corrosion-resistant material.

Worthington Pump and Machinery Corp.
Harrison, N. J.

Fairchild Cornell

B-22

Illustrated pamphlet on Fairchild PT-26 *Cornell*, giving complete design analysis, operation instructions, components and accessories list, specifications for major overhaul, modifications and conditions of sale.

The Babb Company, Inc.
444 Madison Ave.
New York 22, N. Y.

Fluid Magnetic Clutches

B-23

Bulletin describing FM Proportional Torque Controllers, listing configurations, torque output, design features, installation diagrams, performance charts, applications and design history.

Duncan & Bayley, Inc.
785 Hertel Ave.
Buffalo 7, N. Y.

Precision Machines

B-24

40-page illustrated brochure describing the *DI-ACRO* system of "die-less duplicating", and listing various models of rod-parters, benders, shears, brakes and other equipment used in duplicating parts to die accuracy without using dies.

O'Neil-Irwin Manufacturing Co.
Lake City, Minn.

Aircraft Instruments

B-25

New catalog of precision aircraft instruments illustrating and describing both standard and special instruments used in military, commercial and personal aircraft. Especially designed as a reference handbook for engineers and technicians, it contains information on application, operation and performance as well as installation instructions and diagrams.

Kollsman Instrument Div.
Square D Co.
80-08 45th Ave.
Elmhurst, L. I., N. Y.

Portable Lighting

B-26

Bulletin describing *String-a-lite* system of portable or temporary lighting for industrial use. Lists various assemblies available, including handlights and auxiliary equipment. Also gives industrial applications of system.

Mines Equipment Co.
Clayton Ave.
St. Louis 10, Mo.

Glide Stretching

B-27

Safety bulletins by chief engineers giving information for pilots on gliding characteristics of the Model A-35 *Bonanza*, including charts and equations. Additional information on economical engine operation.

Beech Aircraft Corp.
Wichita, Kan.

Hermetic Seal Products

B-28

A 16-page catalog, covering standard and custom-designed seals, illustrating multipoint plugs and multiheaders, high-voltage terminals and solutions of miniaturization, high-altitude and high ambient-temperature problems. Photos of seals are included, as are engineering drawings giving details of alternative designs.

Hermetic Seal Products Co.
37 South 6th St.
Newark 7, N. J.

Fork Lifts

B-29

Bulletin covering complete line of *SpaceMaster* electric and gas-electric fork trucks, with specifications and dimensional drawings for each standard model. Engineering and operational features are described and illustrated, as are accessories, special-purpose attachments and installation methods.

Lewis-Shepard Products Inc.
264 Walnut St.
Watertown 72, Mass.

Sheet-Metal Shop Equipment

B-19

Booklet containing photos, descriptions and specifications of all types of equipment for sheet-metal shops including presses, punches, shear, hand and bench tools for plate and sheet metal work.

Niagara Machine & Tool Works
637-697 Northland Ave.
Buffalo 11, N. Y.

125th Anniversary

B-32

Illustrated pamphlet, commemorating 125th anniversary, showing investigations for which laboratories are equipped in carrying out fundamental research and development for manufacturing industries.

The Franklin Institute
of the State of Pennsylvania
Philadelphia 3, Penn.

Automatic Controls

B-33

Technical bulletins describing *Micropositioner* (polarized relay) and rotary actuator. Relay is available with four different-type bases in both single and double coil. Actuator is designed to meet ANM-40 and has radio-noise filter and dynamic-braking features.

Barber-Colman Co.
Rockford, Ill.

Clevite, Ltd.

CLEVELAND GRAPHITE BRONZE CO has formed a Canadian subsidiary, Clevite, Ltd., which has purchased a factory at St. Thomas, Ontario. Production of sleeve-type automotive engine bearings will start there early in 1950.

John W. Dixon, vice-president and treasurer of Cleveland Graphite Bronze, is the president of Clevite, Ltd., and William Martin, manager of the branch factory in Bridgeport, Ohio, will be general manager of the new plant.

New Advance Plant

ADVANCE ELECTRIC & RELAY CO., manufacturer of relays and other electrical equipment at Los Angeles for approximately 35 years, has started the construction of a new factory in Burbank, Calif. The new plant will about double the present floor space of the company.

Recently, Advance has expanded to a full line of hermetically sealed relays for aircraft.

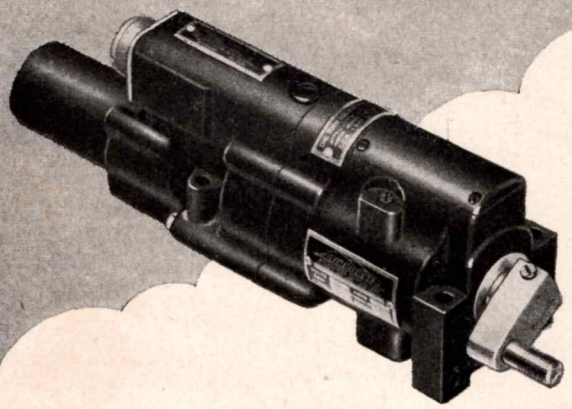
Amphenol leads with the broadest availability listing of AN Connectors built to the new specifications.... MIL-C-5015
AMERICAN PHENOLIC CORPORATION
1830 SO. 54TH AVE. CHICAGO 50, ILLINOIS
AMPHENOL

Trim Trol

DOES THE JOB
on the LATEST
BANSHEE

• Rudder Trim Tab Actuation

• Aileron Trim Tab Actuation



Selection of the "Trim Trol" for Aileron and Rudder Tab Actuation on the XF2H-1, F2H-1 and F2H-2 McDonnell "BANSHEE" was based upon the compactness and simplicity of installation combined with the inherent weight saving obtained by using the actuator for a portion of the mass balance.

We suggest you investigate the advantages of the "Trim Trol" principle for your current designs.

AIRBORNE
ACCESSORIES CORPORATION
25 MONTGOMERY ST. • HILLSIDE 5, NEW JERSEY
6926 MELROSE AVE. • HOLLYWOOD 38, CALIFORNIA
W. N. WRIGHT • DALLAS, TEXAS

Names in the News

Personnel changes and promotions in aviation and allied industries

Lukens

Treman

Hopkins

Kline

• HERBERT D. BISSELL has been appointed executive in charge of the advertising, sales promotion and merchandising depts. of Minneapolis-Honeywell Regulator Co.

• JOHN L. COLLYER, president of the B. F. Goodrich Co., has been made a Chevalier of the Legion of Honor by the French Republic.

• LOUIS DE GARMO, veteran advertising man, has formed de Garmo Inc., a new advertising agency, with offices at 57 Park Ave., New York. He is president.

• SCOTT E. DRUMMOND, construction and maintenance chief for Esso Standard Oil Co., has received official commendation for his wartime assistance to the Air Transport Command in establishing fuel-servicing facilities across Africa.

• J. T. DUGALL has been named plant manager of the Kaiser Aluminum Cable plant at Newark, Ohio.

• CLARENCE H. ENDRESS has been appointed chief engineer of Willard Storage Battery Co.

• CHARLES H. GLASIER, JR. has been appointed manager of distribution of Air Reduction Sales Co., div. of Air Reduction Co., Inc.

• WILLIAM R. HOPKINS has been appointed director of engineering in charge of all development and engineering activities for Airborne Accessories Corp.

• RAPHAEL G. JETER, general counsel of the B. F. Goodrich Co., has been elected secretary and general counsel of the company.

• FRED KAISER, formerly regional midwest manager for Minneapolis-Honeywell Regulator Co., has been promoted to the newly created post of field sales manager.

• OTIS E. KLINE has been named executive asst. to the president of United Air Lines.

• K. F. LEAMAN, works manager for Consolidated Vultee Aircraft's San Diego Div., has been appointed asst. division manager.

• WILLIAM H. LUKENS, fermerly export-sales vice-president of the R. M. Hollingshead Corp., has been appointed to the newly created post of general sales manager.

• JOHN MCVEIGH has been named special development engineer for Kennametal Inc.

• CAPT. JOHN H. MILLER, pilot for Pan American-Grace Airways, Inc., recently completed his 25,000th flying hour.

• HERBERT F. MILLEY has been appointed traffic manager for the Pacific-Alaska Div. of Pan American World Airways with headquarters in San Francisco.

• JOHN J. O'NEILL has been elected secretary-treasurer of Air-

Trapani

Reedy

Versfelt

Willmot

craft Maintenance International, Inc.

• DON M. PARKER has been appointed general sales manager of Piper Aircraft Corp.

• ROBERT E. REEDY has been appointed manager of the sales engineering dept. of Lockheed Aircraft Corp.

• LAWRENCE B. RICHARDSON has been appointed director of research of Fairchild Engine and Airplane Corp.

• JOHN V. SHARP of Bausch & Lomb Optical Co., received the Sherman Fairchild Award for "outstanding achievement" in the field of aerial photography, for work on development of the Auto-focus Rectifier.

• HAROLD C. STUART, Asst. Secretary of the Air Force, has been named an Air Force member of the Research and Development Board.

• EDWARD V. TRAPANI has been appointed *Constellation* project engineer of Lockheed Aircraft Corp.

• S. M. TREMAN has been appointed general manager of the Guided Missiles Div. of Fairchild Engine & Airplane Corp.

• ARTHUR S. VERSFELT has been elected treasurer-controller of Aircraft Engine & Parts Corp.

• ROSS WILLMOT, former information officer of Canada's Dept. of External Affairs, has been appointed public-information officer for A. V. Roe Canada, Ltd., at Malton, Ontario.

Kindelberger Heads IAS

JAMES H. KINDELBERGER, chairman of the board and chief executive officer of North American Aviation, Inc., has been named the 1950 president of the Institute of the Aeronautical Sciences.

1950 vice-presidents of the IAS include Wellwood E. Beall, vice-president engineering and sales, Boeing Airplane Co.; William K. Ebel, vice-president in charge of engineering, Canadair, Ltd.; William Littlewood, vice-president of engineering, American Airlines, Inc.; and E. G. Stout, asst. to chief engineer, Consolidated Vultee Aircraft Corp.

The new treasurer is Elmer A. Sperry, Jr., vice-president and treasurer, Sperry Products, Inc.

Beech Election

AT THE annual meeting of stockholders of Beech Aircraft Corp., directors and officers elected for the coming year are: Walter H. Beech, president; O. A. Beech, secretary-treasurer; John P. Gaty, vice-president and general manager; T. A. Wells, vice-president and chief engineer; R. K. Beech, vice-president, procurement; Frank E. Hedrick, vice-president and coordinator; and L. Winters, asst. secretary.

Walter H. Beech, O. A. Beech, T. D. Neelands, T. A. Well, and John P. Gaty retained their places on the board of directors. Dwight S. Wallace, corporation general counsel, was elected a director.

Accepted the World Over

as the STANDARD *Distress Signal*

DAYNITE

REG. U. S. PAT. OFF.

SMOKE FLARE

DISTRESS SIGNALS

MILITARY DESIGNATION

SIGNAL (DISTRESS DAY AND NIGHT) AN MARK 13 MOD 0

Standard Distress Signal of the U. S. Armed Forces and adopted by the Governments of Argentina, Australia, Canada, Chile, Netherlands, Netherlands Indies, Portugal, Sweden, etc.

Exclusive DAYNITE construction hermetically seals each individual signal in metal... guarantees moisture-proof dependability!

Day and night protection of vivid orange smoke signal and brilliant red flare in opposite ends. Obsoletes pistol projected, floating and paper-wrapped, fireworks-type distress signals.

Approved by U. S. Coast Guard No. 160.023/1/0
Approved by Civil Aeronautics Authority and specified by Air Transport Association

AERIAL PRODUCTS, Inc. ELKTON, MARYLAND

WORLD'S LARGEST MANUFACTURER OF DISTRESS SIGNALS

Helicopter Flight Test

and

Dynamic Test

Instrumentation Engineer

PIASECKI

Helicopter Corporation

. . . HAS AN OPENING FOR AN INSTRUMENTATION ENGINEER OF THE HIGHEST CALIBRE WHO HAS THE FOLLOWING QUALIFICATIONS:

AGE—not over 35 years.

EXPERIENCE—Over five years' experience in aircraft, flight and dynamic test instrumentation preferably helicopters. Extensive knowledge of operation, maintenance and application of strain gauges, oscillographs, vibration equipment, photopanels and aircraft instruments. Must be a practical engineer who is technically capable of solving unusual problems of instrumentation, of maintaining equipment and organizing an instrumentation laboratory.

EDUCATION—Minimum of a B.S. Degree, aeronautical or electrical engineering from a recognized engineering school. Prefer man with graduate experience.

SALARY—open and will depend on the individual's qualifications and experiences. As flight test instrumentation engineer he will be required to participate in helicopter flight tests. Write, giving age, experience and education to—

PIASECKI HELICOPTER CORP.

MORTON, PENNA. (Philadelphia Suburb)

Improved

DC-4

ENGINE MOUNTING

CAA APPROVED

New LORD Dynafocal Core Delivers Smoother Performance

• • • • • •

Longer Service Life

The *new* LORD MR-26-1B Dynafocal Core is now available. DC-4 operators should specify this superior core for replacements. Here is why.

- Increased Service Life.
- Increased Protection Against Metal-To-Metal Bottoming.
- Increased Passenger Comfort.
- Less Frequent Replacement.
- Lower Maintenance Cost.
- Directly Interchangeable With Those Now In Use.

MOUNTINGS FOR EVERY AIRCRAFT NEED

For any type of aircraft, or any aircraft application, LORD can supply the Mountings you require. Our specialized knowledge and experience in Vibration Control is at your service.

LORD MANUFACTURING CO.
ERIE, PENNA.

Canadian Representative:
Railway & Power Engineering Corp. Ltd.

LORD
Engineered Vibration Control

(Continued from page 74)

speak, in our scientific stride. However, conditions in the not-too-distant future will be hardly comparable, and their impact upon the science of aviation medicine will be considerable.

A major function of the science of aviation medicine has been and always will be that of predicting and solving the human problems associated with the expansion of flight into areas in which there is no corollary in human experience. In the past, our areas of study, for the most part, had some sort of boundary definition. In the early days, there was the altitude barrier imposed by anoxia. This barrier was soon pushed outward by use of supplementary oxygen. Later, another barrier was interposed by decompression sickness. This was surmounted by pressurization.

Then the sonic barrier came along to limit our thinking and our study, as we were of the impression that this was a limitation of speed beyond which carriers could not travel. New methods of propulsion and new airfoil designs rather quickly pushed this obstacle aside.

Now then, suddenly, vast new areas are opened and this challenge presented to us. In my opinion, and I am certain the opinion of many others, this challenge will have to be met not by selection or alteration of man but by changing his position in the control chain.

Rather than leaving him in his position as activator of the controls, he will be relegated to a primary position of control and maintaining the control devices which ultimately determine the operation of the carrier. This change of position in the control chain will necessitate many revisions of our attitudes toward the operation personnel, especially in the realm of selection.

BIBLIOGRAPHICAL NOTES

1. Wiener, Norbert. *Cybernetics*. Technology Press, John Wiley & Sons, Inc., New York, 1949.
2. Ley, Willy. *Rockets and Space Travel*. Viking Press, New York, 1948.
3. Struchold, Hubertus, "Physiological Aspects of Space Travel," Outline, U. S. A. F. School of Aviation Medicine, Randolph Field, Texas, 1949.
4. Perring, W. G. A. quoted by Ley in *Rockets and Space Travel*, pp 350. The Viking Press, New York, 1948.
5. *Handbook of Chemistry and Physics*, 25th Edition, Chemical Rubber Publishing, Cleveland, Ohio.

MILWAUKEE AIRPORT

(Continued from page 41)

tions are not what they should be. Flyers, however, have minimized the hazards at the field.

In addition, many feel that development of the field has been hampered by the many delays which have surrounded the project. Appropriations for the first-stage development program were snarled repeatedly before they actually were made available. And even now there are some clouds hanging over the second-stage program.

Most concrete is the fact that the commercial firm now operating the field reports fairly substantial operating losses in its first year of operation and this, to many, is hardest of all to take.

John P. Henebry, operator of the airstrip, reported to Milwaukee's Common Council in June 1949 that his firm was in financial difficulties. He said that he would be un-

• A very few bound volumes of back numbers of AERO DIGEST have been acquired and will be sold to first comers at $6 each, carriage prepaid.

• Bound in sturdy cloth, with gold-stamped label, the individual volume is 8½ by 11 inches, comprises nearly 1000 pages and weighs upwards of five pounds.

• This very unusual collection of important and extremely useful aeronautical information, to be sold in single units or all together, is as follows:

JAN.-JUNE 1932
JULY-DEC. 1932
JAN.-DEC. 1935
JAN.-DEC. 1936
JAN.-DEC. 1937
JAN.-DEC. 1938
JAN.-JUNE 1939
JULY-DEC. 1939
JAN.-JUNE 1940
JULY-DEC. 1940
JAN.-JUNE 1946
JULY-DEC. 1946
JAN.-JUNE 1947
JULY-DEC. 1947

•

AERO DIGEST

515 MADISON AVENUE
NEW YORK 22, N. Y.

All orders must be accompanied by check or money order.

COMPLETE COVERAGE OF AMERICA'S MULTI-BILLION DOLLAR AVIATION MARKET!

AERO DIGEST now offers you *each month*, in addition to its comprehensive ABC coverage, a NEW and HAND-PICKED list of

- AERONAUTICAL EXECUTIVES
- ENGINEERS
- DESIGNERS
- MAINTENANCE MEN
- COMMERCIAL FREIGHT and PASSENGER AIRLINE OPERATORS
- PURCHASING AGENTS

That's COMPLETE PURCHASING-POWER COVERAGE of the key men who do the developing and buying of Aeronautical Equipment, Supplies and Accessories for the aviation industry of the world!

These are the same men who will read AERO DIGEST's **11th ANNUAL DIGEST,** coming in March—a complete Directory of Aircraft, Powerplants and Accessories. They will use this issue throughout the year as a dependable, factual reference-book. It will be the most authentic and informative aeronautical publication of 1950!

WITH TWENTY-EIGHT YEARS OF PROVED ADVERTISING VALUE, AERO DIGEST OFFERS YOU THE **11th ANNUAL DIGEST** AS YOUR NUMBER ONE BUY OF 1950 . . .

Only a few days left to place your advertising. Contact your local representative at once — CLOSING DATE, February 17th.

AERO DIGEST

"America's Premier Aeronautical Magazine"

515 Madison Avenue New York 22

PLaza 3-6969

COMPLETE COVERAGE OF THE ENTIRE AVIATION MARKET WITH ONE PUBLICATION

• ***Established in 1922*** •

able to fulfill commitments to the city for investment of $175,000 in hangars and shops at the airstrip, and that at least $75,000 in working capital was needed to promote the airstrip properly. In the face of this report, Milwaukee officials countered with an offer to modify the firm's lease and to attempt to devise other means to finance the field properly.

Despite delays and objections, however, development of Maitland is going ahead. The doubters are a distinct minority; the majority of Milwaukeeans are determined that their city eventually will have a useful, efficient, convenient downtown airfield. There is no question as to their determination and enthusiasm.

In midsummer of 1949, for example, Milwaukee's Harbor Commission recommended the further improvement of Maitland, despite the reports of operating losses. Along with the majority of taxpayers, the commission felt that Maitland Field and its potentialities could not be judged by its past limited and hampered use. The belief exists that, in the past, Maitland has been little more than a bare field with a single runway and some taxiways, that all the appointments and services that yield returns have been absent or have operated under difficulty. It is believed that there has been no fair test so far as revenue is concerned, and that there never will be until the investments are made that will make Maitland the efficient, convenient airfield it can be.

The spur of metropolitan competition plays no small part in that belief. With Chicago's Northerly Isle field now in full-time operation and with Cleveland's lakefront field operating successfully, Milwaukee feels that Maitland is vital if the city is to approach an equal footing in air transportation. Civic leaders believe that Maitland is necessary to maintain Milwaukee's industrial position in competition with Chicago and other major cities.

Whatever may be the situation concerning operating losses and delays in construction of improvements, there is no necessity to paint the picture at Maitland in black. On all sides there are signs of tremendous strides in the use of the field and in its gradual acceptance as a field of importance.

As an example, the airstrip's log for the month of May, 1949 showed that nearly 600 persons from Wisconsin and 10 other states flew to Milwaukee via the city's lakefront, downtown airstrip. Figures showed that 253 planes used Maitland during the month, and attendants estimated that pilots of at least 50 others failed to register.

In December 1948, when the refurbished Maitland field was dedicated, the first plane to fly from the newly dedicated field to Chicago's lakefront port completed its flight in 32 minutes. This gave rise to a more than casual discussion of an eventual hourly flight schedule between the two cities and their downtown areas.

In December 1947, a new traffic interchange at Milwaukee's Lincoln Memorial Bridge on the eastern tip of Wisconsin Avenue overlooking the lakefront was opened. This divided roadway made Maitland far more accessible than it ever had been before and, in itself, was a tremendous boost to convenience.

When all is said and done, Milwaukeeans are convinced that there isn't any question but that their city *needs* this downtown airport. Situated within five minutes drive from the business center, it has already shown that it will stimulate both wholesale and retail trade. There is general agreement that it will be a great convenience to the flying public and industrial executives seeking to do business in Milwaukee.

While, up to now, the improvements that have been made are principally physical, Milwaukee residents and businessmen are looking further ahead to make the Maitland strip a thoroughly useful and beneficial air-transit facility for the community.

One of the first objectives is to tie in with Chicago's lakefront field. With Maitland only five minutes from the downtown section and Chicago's Northerly port only a few minutes' drive from the Loop, the two cities would be tied together with the fastest possible transportation.

Milwaukee is looking to Maitland also to provide service for regularly scheduled feeder lines that reach out into the whole of Wisconsin, thereby tying the state's other sections with its metropolis through highly advantageous commercial aviation. Under such a system, Maitland would eliminate the usual time lag in getting to and from outlying airports, a matter that is particularly important where comparatively short flights are involved.

Further, Milwaukee is determined that Maitland will be attractive and comfortably serviceable to commercial, industrial and private flyers.

All this, however, takes time.

Maitland field, with its capacity for serving industry, commerce and travel, stands now in a particularly crucial stage. Milwaukeeans know that the downtown field, with its unusually advantageous downtown location, is not something to be lost lightly. That is why any and all plans to improve Maitland Field, slow and halting though they may be, receive the full support of citizens interested in making Milwaukee a better place in which to live.

TOOL REWORK AND PRODUCTION

(Continued from page 60)

concerned should be provided with an opportunity to participate in improving job methods.

In cases where the rework request is not approved, it is wise for management to realize that the person requesting the rework should understand the reasons for the disposition. If this point is overlooked, the worker is apt to take a negative attitude toward the company and task involved.

At Schweizer Aircraft, the tool request form and order—illustrated above have been developed over a period of years in line with the above comments. The rework order actually is on the back of the request form, so that the tool man gets the complete story and paper work is minimized.

When the rework request is approved, the order card is routed to the personnel charged with the responsibility of controlling production. They indicate the status of the parts involved, according to the requirements of the production schedule, and assign an order number (for charging time) to the job. The card is then turned over to the tool-shop foreman, who will schedule work in his department according to production's requirements.

Often, a little special emphasis on tool-work, through overtime or other means, will avoid production delays which build up large amounts of production-line overtime. It is felt that there is a tendency, in the aircraft industry, to go along with a little too much control on routine production and insufficient control of those basic functions, such as tool rework, coordination of engineering changes and scheduling of critical operations, where major production bottlenecks many times occur.

When the tool department completes the rework, the tool and order card are turned over to inspection for approval. It is not uncommon for an inspector to call in the production foreman or the individual who requested the rework to concur in its approval. When the tool is approved, it is routed to the tool storeroom and the order card is sent to the office. For large tools which are impractical to move, the same procedure is used; but reworking and inspection are done on the production line.

In the office, the card will go directly to the person charged with production control, telling him that the tool is now ready for work. Production then turns the card over to a timekeeper, whose duty it is to pick up all the direct labor in the shop each day on time tickets. When he receives a completed order, he accumulates the time charged against the order number and indicates it on the completed order card. The card is then filed with the original tool order, which provides a complete case history of the tool in terms of mechanical problems involved and direct labor required for construction and rework.

In war or peace, the aircraft manufacturer's product is in a continual state of change. Therefore, our production setup must be adjusted gradually to meet the changing requirements of our research, test and design engineers. The procedure described above also will provide a systematic method for coordinating tool reworks required by design changes.

For example, when an engineering change is released to production, the changes will be studied by production, and any tools that can be brought up to date by rework will be given that attention through the procedure outlined herein. The request on the card will indicate merely the reworking of the tool according to specific engineering change order number, with any comments necessary.

To the aircraft subcontractor, it is sometimes important to be able to determine direct labor charges for reworking tools in order to incorporate engineering changes, since he is usually permitted to bill the customer or prime contractor for its extra cost. This rework-control procedure will provide the company with an opportunity to determine its charges, if it feels the cost involved in accumulating job-order time is worth its while.

TURBOJET COMBUSTION-CHAMBER PROBLEMS

(Continued from page 56)

boiling away of the liquid from the wall where it is hotter. Carbonaceous deposits resulting from residual fuel constituents in the hotter location of the wall—as in the wakes of the round air jets entering the holes—can be minimized by attempting to reduce the bombardment of the wall with liquid fuel, by operating with either fairly hot or fairly cool walls, or by sweeping the wall surfaces mechanically with air films. The last-named method has been found the most satisfactory.

No general rules can be laid down for the proper spacing or size of the air slots admitting this air to sweep the walls. However, the desired total primary air is known, and the velocity with which it should enter the lateral holes is known, together with the amount, if a burner of the type having wall holes is used. (The amount is approximately half the total primary air.) In this manner, the total slot in the primary section may be estimated.

Bunker C oil and light fuel oils have been burned cleanly, without carbon deposits, by concentrating attention chiefly on the wall-sweeping process.

Fig. 1 shows that rather high flame temperatures may be expected at some locations in the reaction zone of the burner, possibly as high as 4000°*R*. Ceramic liners were considered at an early stage in the development of turbojet combustion chambers. However, interest in such materials was short-lived because of the danger to the turbine in the event of breakage of a liner. Although a future interest may be revived in ceramic liners, we are concerned at present with the building of all-metal combustion chambers.

The melting point of ordinary heat-resistant steels is about 3050°*R*, while their scaling temperature is much lower—about 2400°*R* for 25 *Cr*—20 *Ni* material. This cannot be tolerated in combustor liners because of non-uniformities in temperature. The chief difficulties affecting wall durability arise from distortion of the surfaces and cracking due to stress cycling. On this account, attempts to improve durability by using metals with good resistance to high temperatures, or by strengthening the walls with external stiffeners, are not successful in general.

A small annular combustion chamber (10.5*in diameter casing*), with wall stiffening produced by rolled grooves, circumferentially, was run for 10 hours, as follows:

(*a*)	Four hours continuous burning	
	Outlet temperature	1540°*F*
	Air rate	2.52 *lbs/sec*
	Burner pressure	16.4*psia*
	Fuel rate	0.0544 *lbs/sec*
(*b*)	Six hours continuous running	
	Outlet temperature	1537°*F*
	Air rate	2.54 *lbs/sec*
	Burner pressure	24.2 *psia*
	Fuel rate	0.0544 *lbs/sec*

In this case, the burner survived the test in fairly good condition. However, this time is a great deal shorter than that commonly demanded of combustor flame tubes or liners.

The most successful approach to securing good durability of the liner and end plate or dome is to employ means to cool these metal surfaces. Attaching external fins was tried and found not very successful on account of warpage. The most suitable way of cooling the walls was found to be by internal air blankets.

The blanket of cooling air may be built up either by employing louvers in staggered arrangement, or by continuous slots. Continuous slots give a more uniform cooling effect than do louvers. Such slots are represented schematically in *fig. 3*. The blankets of air entering through such slots serve not only to cool the wall downstream from the slot, but also to sweep away incipient carbon deposits.

Some idea of the cooling effect of such slots can be gotten by a simplified analysis, which assumes that one of the sections of the flame tube (between two cooling slots) behaves as a heated skin-friction plate, which receives heat by radiation from a luminous flame and looses heat by radiation to the outer casing and by convection to the boundary layers on each side. The heat given up by convection might be arrived at, for laminar boundary-layer conditions, by the Pohlhausen theory, which gives

$$q_x = 0.664\ k\ P_r^{1/3}\ (u_o\rho_o/\mu x)^{1/2}\ (T_w - T_o)$$

and for turbulent boundary-layer conditions by the theory of Latzko, from which

$$q_x = 0.057\ u_o\rho_o c_p R_x^{-1/5}\ (T_w - T_o)$$

In these equations

q_x = heat lost per unit area for two sides of plate.

u_o, ρ_o, μ = velocity, density and viscosity of stream approaching the plate

k = thermal conductivity of air

P_r = Prandtl number, $c_p\mu/k$

c_p = specific heat of air

R_x = Reynolds number, $u_o\rho_o x/\mu$

x = distance from leading edge of plate

T_o = temperature of approaching stream

T_w = local temperature of plate

Using the above relations, heat-balance equations may be set up for any unit area of the plate. For a laminar or turbulent boundary-layer, we have, respectively

$$\sigma\left[\epsilon_f\ (T_f^4 - T_w^4) - \epsilon_o\ (T_w^4 - T_o^4)\right] = \frac{0.664\ c_p u_o \rho_o\ (T_w - T_o)}{P_r^{2/3} R_x^{1/2}}$$

$$\sigma\left[\epsilon_f\ (T_f^4 - T_w^4) - \epsilon_o\ (T_w^4 - T_o^4)\right] = \frac{0.057\ c_p u_o \rho_o\ (T_w - T_o)}{R_x^{1/5}}$$

where

σ = Boltzmann's constant, 0.48 x 10^{-12} *Btu/ft² sec deg⁴*

ϵ_f = flame emissivity, assumed 0.5

ϵ_o = metal emissivity, assumed 0.8

T_f = temperature of luminous flame

T_o = casing temperature, as well as approaching gas temperature

If we let

$$\alpha = \frac{c_p u_o \rho_o}{10^4 \sigma T_o^3}$$

we may calculate and plot R_x as a function of T_w/T_o for various assumed values of α and of the ratio T_f/T_o, for both the laminar- and turbulent-flow conditions. This has been done and results are shown in *fig. 7*.

Inasmuch as the conditions governing transition here are very obscure, we have shown simply the laminar-flow temperature distribution up to R_x = 200,000, and the turbulent boundary-layer wall-temperature pattern from R_x = 100,000 or out to 1,300,000. Just where the transition occurs is an open question, but it probably occurs at pretty low R_x values since the airstream flowing past the combustion chamber is quite turbulent, and the edges of the metal wall sections are generally blunt.

The above treatment may be expected to give wall (liner) temperatures which are if anything, too low. This is because the heating of the inside boundary layer, between

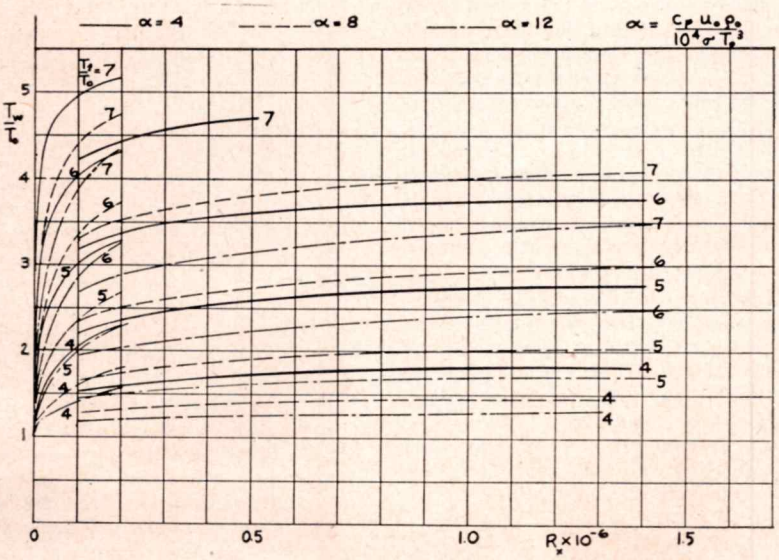


Figure 7

the liner and flame gases, has been neglected. This latter effect may be very influential, but one is baffled in attempting to pick suitable assumptions for an analysis of the process.

Experimentally, wall temperatures have been measured by the writer at points about 1.5 *in* downstream from the slots, and temperatures roughly 1000° above inlet temperature were commonly observed for flame temperatures in the neighborhood of 4000° *R*. The experience with such cooling steps on aviation gas-turbine burners is that the liners can be made to run at a temperature below that of visible radiation for inlet temperatures of a few hundred degrees.

The life of combustor liners and end plates has been increased several fold by this means in recent years. The life of the burner is, for all practical purposes, as long as the life of the turbine itself.

Since, with an annular burner, the combustion process is carried out in one large chamber instead of a number of small cells, the amount of air and fuel to be supplied for testing and development becomes enormous. This is a rather serious disadvantage of the annular combustor and, were it not for certain other attractive features of this type of burner, it would probably rule out annular combustors from consideration.

In addition to this economic problem there also are difficult technical problems. These arise because of the many fuel nozzles in the single combustion chamber, the burner shell is not radially symmetrical about the axis of any one fuel nozzle, and the cooling and mixing process is more difficult to control in the annular burner. In the Westinghouse laboratories, development projects have been carried out on both cell-type burners and annular burners, and it is readily admitted that cell-type chambers are perfected more readily.

One means of reducing the magnitude of the testing operations with annular burners is to work with sector-shaped models, of 60° or 90° subtended angle. This procedure is satisfactory as to investigation of burning range, efficiency, carbon deposition, pressure drop and durability, but is not satisfactory for investigation of outlet-temperature distribution. That problem is just the one which is accentuated most in annular burners as compared with cell burners. A sector-shaped burner has end effect along the radial side walls which make investigation of circumferential temperature patterns practically hopeless. The final configuration changes for effecting the desired outlet-temperature distribution must be worked out on a full annulus combustion setup, or in the assembled engine.

The attainment of a circumferentially uniform outlet temperature, and a radial temperature pattern as desired for the turbine blades, depends upon a number of factors. First, there is required a good uniformity of total pressure in the airstream coming from the compressor and uniform fuel distribution to the fuel nozzles, so that the primary air-fuel ratio will not have peaks circumferentially. Second, the flow pattern in the reaction section must be such as not to upset this fuel-air ratio pattern, as would be the case, for example, were air currents to develop in the ignition zone which tend to channel the fuel spray into fuel-rich filaments. Third, the secondary air must be admitted in a manner which will insure its adequate penetration and uniform mixing before the gases reach the turbine nozzles.

One undesirable situation that may occur when the secondary air is admitted through axial rows of holes, or from axial slots, is an instability of the parallel airstream. This situation has been discussed by Bohl[2] and others. Several successful devices have been developed to avoid the danger of this merging of adjacent secondary jets.

Although there are special problems arising in annular burners, it is only fair to mention some of the attractive features of these burners. First, there is the matter of more compact construction and the possibility of a smaller over-all engine diameter. Second, the ignition problem is simpler, since only one spark plug need be used (though two generally are used for a margin of security). Interconnecting tubes are not necessary, as they are on cell-type burners.

Third, the surface area of the liners, or burner walls, is smaller for a given flow cross-section, than is the case with multiple cells. This leads to less surface to be cooled, less surface to accumulate carbon and less surface to be in the path of direct fuel impingement. Fourth, as blowout conditions are approached, sections of the burner which, for some reason may be more favorably disposed for continued burning, can serve as sources of continuous ignition for other sections of the burner which would be prone to blow out.

REFERENCES

1. Durand, *Aerodynamic Theory*, Vol. VI, pages 238 and 269
2. J. G. E. v. Bohl, "Das Verhalten Paralleler Luftstrahlen," *Ing. Archiv.* v. XI, 1940

20TH CENTURY LIMITED

(Continued from page 49)

We knew that pilotless aircraft loaded with bombs were useless—until the Germans sent the V-1 over England. As for rockets, guided missiles, they were still far away in the Buck Rogers era until the Germans sent the V-2 over England—though too late to save the day for them. And we thought that poison gas would be employed—but it wasn't.

Our best-informed military minds believed that Russia would collapse in eight weeks—and I went right along on that one, too, so I'm no smarter than the generals! Nor was Hitler, who failed to read Caulaincourt's story of the retreat of Napoleon from Moscow a century before, and didn't know that the weather in Russia hadn't changed for the better since then. Of course, we do know that—so we're hoping that the bad Russian weather will permit us to send unescorted intercontinental bombers over Russian industrial centers, far in the interior, without their being intercepted by Russian jet fighters. On that score, I feel that the top brains of our Air Force should send a message to Napoleon and Hitler: "Move over—we're joining you!"

The prize boner of all time seems to have been made by the U. S. Navy—unless you choose to offer instead the mad dash to destruction of the German battleship *Bismarck. The Navy entered the war with untested torpedoes,* with the not unnatural result that, on some submarines, 37½% of the torpedoes fired were defective. It was not until August 1942, eight months after the war's start, that the Bureau of Ordnance, after needling by Admiral King, rechecked its data and found that the torpedoes were running 10 feet too deep!

Submarine commanders made round-trip cruises of 8000 miles, gained attack positions within 800 yards of enemy ships, and then fired duds! Why? Because torpedoes cost $10,000 apiece, and we were too poor to expend them in any firing practice at old vessels before the war. The Japs made prewar tests—and, if their torpedoes were aimed right, they hit and exploded.

There were also premature explosions of American torpedoes—which may have accounted for the loss of some of our submarines. The policy of top secrecy maintained by the Bureau of Ordnance was such that, for 16 years before the war, only a few captains and torpedo officers knew anything about the magnetic-influence exploder. When our fighting men had to use it, they were largely ignorant of its working and faults.

It is this "top secrecy" in military affairs that covers up a multitude of faults—though not intentionally. The hush-hush policy is supposed to delude the enemy, not the American citizen. But it does both. Take, for example, the charges by the Navy that the Air Force is making a billion-dollar blunder with its B-36 program.

Official Washington and many newspaper editors deplored that some of the technical facts in an inter-Service disagreement should have been aired for the information of the public and undoubtedly the satisfaction of the enemy. It was charged that, by belittling the capabilities of the B-36, the Navy was undermining public confidence in the Air Force and letting the Russians know that some experienced air officers didn't think the big craft could do its war job and survive, except briefly. But, if it can't do its job any better than Navy torpedoes did their job during the first year of the past war, the best time to find out is before war starts.

We may regard this B-36 disagreement with composure, leaving the decision to the Weapons Evaluation Board. If the B-36 turns out to be useless as an intercontinental *unescorted* bomber (as I darkly suspect that it will) the big aircraft will still be as useful in war as our battleships. Like them, they can serve as transports and tankers.

Of course, the long-range, guided missile must be fired from somewhere from something. Possibly the big bombers and the battleships may see action in the next war as guided-missile launching platforms. I offer the idea for what it may be worth—if it has not been proposed already.

Now, where is all this super-intelligence to come from? Possibly from the Army, the Navy and the Air Force. On the record of past performances, all three are suspect, though the Army comes off better than its team-mates. It made fewer blunders, fewer extravagant claims that couldn't be backed

up in war. The Army kept its feet on the ground. Furthermore, the Army now understands the need of close air support if it is to get anywhere or even survive in battle; and it always has understood the need for a strong Navy to guard it when it goes overseas and to protect its supply lines.

The Services about which we should be concerned are the Air Force and the Navy, both of which seem lost in their visions of the future.

The Navy is at a loss obviously because it hasn't another surface Navy to fight. At the Armed Services Committee hearing, General Omar Bradley said in part:

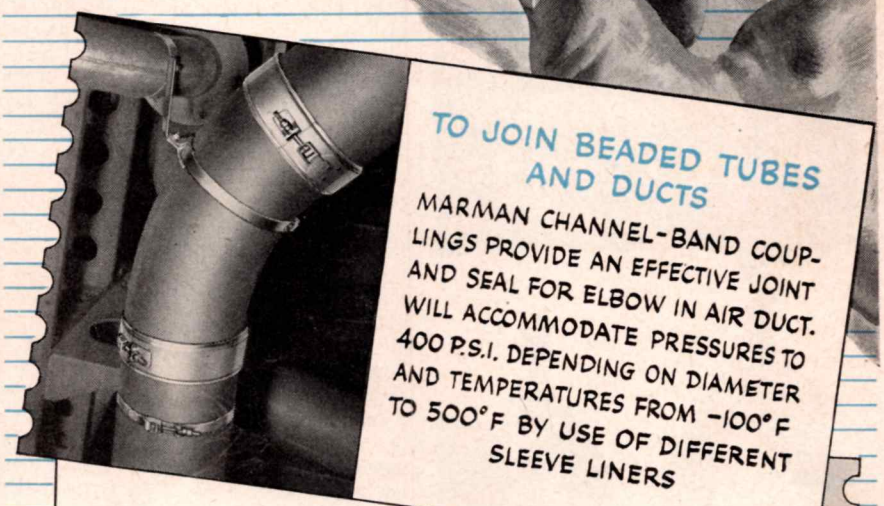
> "Considering again the only possible enemy we have in sight, we are faced with the real fact that the Soviet Union and her satellites have tremendous land forces, but their surface navy is negligible.
>
> "Now I personally believe in Naval aviation, and especially in the hunter-killer task forces that are needed to fight Soviet submarines; and I endorse wholeheartedly an adequate program of Naval aviation to assure us of control over enemy navies and the ability to subdue the sterner submarine menace.
>
> "However, in listening to the presentations before the Joint Chiefs of Staff, the arguments for increased large carriers have not been based for need against a Russian fleet, nor even on Naval aviation against the menace of the submarine. Their presentations demanded increased carrier strength to attack land targets and to oppose hostile air in limited areas for a limited time. This is not the Navy's primary mission.
>
> "Such power would be nice to have, but does it contribute as much to the requirements to meet the initial stages of a war as the same amount spent for other more vital needs? It cannot be furnished without reducing the strength of either the Army, the Air Force or the Navy's ability to perform its primary mission of keeping the sea lanes open."

General Bradley was justified in his analysis. In its testimony before the Armed Services Committee, the Navy restricted itself to stating what might be wrong with the Air Force. It never even hinted at what might be wrong with the Navy.

The chief trouble is that, for all practical sea-war purposes, the Navy has discarded the big gun and the battleship. The bombardment of shore positions is a minor activity for which, in a future war, there probably will be only an occasional need. The Navy has had the airplane, with its airborne bomb and torpedo, practically forced upon it by the actualities of the past war—before which the battleship was considered to be the capital ship and the carrier only an advance scout, in the heavy-cruiser class. It was a bitter blow to the battleship admirals to learn that sea-based air power could defeat surface navies and render the big naval rifle obsolete.

The present *air* admirals now are faced with this problem; the bombing plane is set aside, in public (and even Congres-

ENGINEERS NOTEBOOK

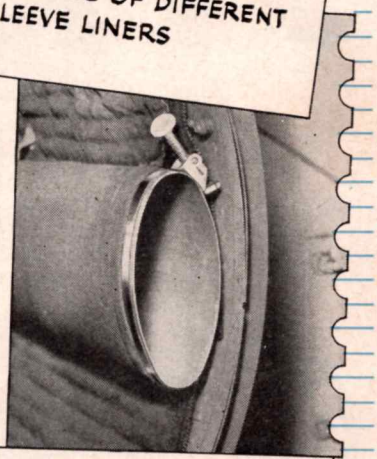


TO JOIN BEADED TUBES AND DUCTS

MARMAN CHANNEL-BAND COUPLINGS PROVIDE AN EFFECTIVE JOINT AND SEAL FOR ELBOW IN AIR DUCT. WILL ACCOMMODATE PRESSURES TO 400 P.S.I. DEPENDING ON DIAMETER AND TEMPERATURES FROM -100°F TO 500°F BY USE OF DIFFERENT SLEEVE LINERS

FOR EASY ASSEMBLY OF LOW PRESSURE AIR DUCTING

MARMAN UNIVERSAL (QUICK-DETACHING) CLAMPS SAVE TIME AND COST IN ALL SUCH APPLICATIONS. PHOTO SHOWS DUCT PRIOR TO CONNECTION OF MALE END. FABRIC COVERING PROVIDES SEAL WHEN CLAMP IS TIGHTENED



ATTACHMENT OF FLANGED HOT AIR EXHAUST

MARMAN VENTILATED COUPLING MAKES AN IDEAL ATTACHMENT FOR METAL BELLOWS BETWEEN HOT AIR DUCT AND HEATER. FLEXIBILITY OF THIS COUPLING PROVIDES EASY INSTALLATION IN RESTRICTED AREA

Save cost and design time with Marman

FOR INFORMATION WRITE DEPT. D-2

THE BEST CLAMPS, STRAPS AND COUPLINGS

MARMAN PRODUCTS CO. INC.

940 W. FLORENCE AVENUE
INGLEWOOD, CALIFORNIA

3

The Standard of the Industry

WITTEK
STAINLESS STEEL
Aviation
HOSE CLAMPS

TYPE FBSS

Utilizing the basic Wittek Floating Bridge . . . this type has been tested and proven through over ten years of dependable service on all types of aircraft applications.

TYPE WWD

Pioneered in stainless steel construction by Wittek for greater strength and dependability . . . this type is available in all standard aircraft sizes, also in large diameters from 4" to 12" for ducts and special applications.

Wittek Aviation Hose Clamps meet current AN specifications and have C.A.A. approval.

WITTEK
MANUFACTURING CO.

4306 W. 24th Place
Chicago 23, Ill.

Aviation HOSE CLAMPS

Dependability In Hose Clamps For Over A Quarter Of A Century

sional) thinking, as an Air Force weapon. Although air admirals are well aware that surface sea power has become naval air power, the term "air power" has been trade-marked by the Air Force through years of publicity effort. To a large extent, our navy is the victim of the Book-of-the-Month Club, which did the Navy far more damage by its distribution of a book called *Victory Through Air Power*, than the Japs ever managed to inflict. The Japs sunk only warships; public thinking about air power may sink the Navy as an active offensive force and relegate it to the position of guardian of the sea lanes. In short, the old sea dog is beginning to look vaguely like a sheep dog, guarding the flock.

Our Navy has no strong surface Navy to fight. The Russians have only a submarine navy. And the best way to fight the menace of a greatly augmented and vastly improved Russian submarine navy is by the use of air power. The Navy already has this power, but when it seeks cautiously to augment it—by the building of one modern post-war aircraft carrier—the Air Force and its supporters emit howls of disapproval. "We don't need two Air Forces!" they cry. The Navy believes that we do need two different types of air force—one land based, the other sea-based. But it dares not say so in those plain words. That is the great difficulty.

For the Navy to be as candid about itself as it has been about the Air Force and the B-36, the Navy would have to admit that the problem of the schnorkel and the newer true-type submarine seems to be beyond present Naval capabilities for dealing with it. The submarine of the past war normally spent 80% of its time on the surface. The new types may spend up to 100% of their cruises submerged, subject to detection only by sonar at a distance of a mile or two. Sometimes they cannot be detected at all, because of sea conditions affecting sonar reception. Here, in short, is the almost invisible weapon—rather than the high-flying bombing plane, which can be tracked by radar for over 200 miles.

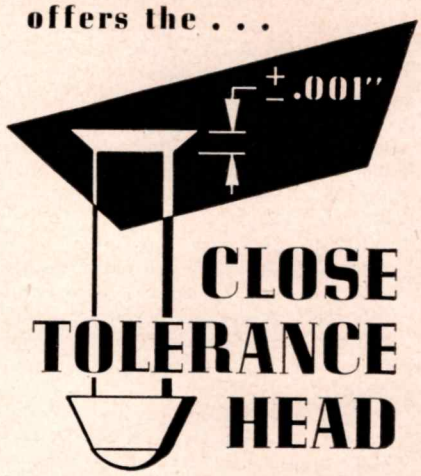
How, then, is the Navy to seek out and destroy enemy submarines that may approach our coasts to discharge guided missiles with atomic warheads? The navy doesn't say. Any anti-submarine measures that the Navy has on tap are in the "top-secrecy" drawer—like the prewar torpedoes and their non-functioning magnetic exploders.

It might be in the interest of national defense for the Navy to admit frankly that trying to deal with Russian submarines by the uncertain method of sea search by carrier planes, destroyers, and submarines is like looking for needles in haystacks—which the Russians must know as well as we do, so we won't be giving them any useful war information. The Navy might declare that the best way of dealing with the submarine is to smash it in its lair—the bases from which it operates; the factories wherein parts for it are manufactured; the points where these parts are assembled. This would be an air-power assignment. No other force can do it.

The only question is: which part of whose air power should do what?

If a factory in the interior of Russia is

Only
HI-SHEAR
offers the . . .



CLOSE TOLERANCE HEAD

in a *steel* fastener to the aircraft industry

the HS-2R7

Aerodynamicists say -

"The HS-2R7 permits smooth surfaces, essential to transonic speeds and laminar flow."

Assemblymen say -

"... rapid installation, without hand fitting in either cut-countersunk or dimpled holes."

Inspectors say -

"... uniform high quality... cuts rework and rejections."

Other features -

- The average Hi-Shear weighs 66% less than its equivalent AN Bolt-Nut-Washer combination.
- Strength comparison — One Hi-Shear equals 2.8 AD rivets.
- Self-adjusting — no threads in bearing — no washers — no torque inspection.
- Standard rivet guns and squeezers — no expensive pullers or special one-purpose equipment.

U.S. and foreign patents — Trademark registered.

THE *hi-shear* RIVET TOOL CO.
1559 SEPULVEDA BOULEVARD
HERMOSA BEACH, CALIF.

making submarine parts, the destruction of that factory is obviously an Air Force assignment. If the destruction of an operating base is decided upon, the force will still have to be air power—sea-based or land-based. What does it matter where an atom-bomb-carrying airplane takes off, from a runway or a ship's deck? The only thing that will do us any good is the delivery of the bomb. The means of launching are immaterial. If a Naval task force can approach near enough to Russian, or Russian-held, coast to deliver an explosion capable of destroying Russian submarine power, that force should be used—unless it is expedient to use the Air Force instead.

As a war against Russia is bound, initially, to be a perimeter war, any forces of the air that can be brought to bear should be used. But if our Navy suggests any such plan, Air Force supporters will complain immediately that the Navy is trying to invade the Air Force's field. So the Navy keeps quiet, and pretends that it is able to defeat Russian submarines by seeking them out in the millions of miles of the oceans.

At this point, both Air Force and Navy propaganda strategists could take over and prove conclusively that the destruction of a Russian submarine base or shipyard is a Navy task—or an Air Force task, depending upon the service they represent. It would prove only that a typewriter is an adaptable instrument, which, on the whole, the Air Force has demonstrated more capably than the Navy.

The Air Force, basking at present in a much better public-relations light than the Navy, seems headed for a rude awakening on war's outbreak. Setting aside the merits of the intercontinental bomber controversy, the Air Force has claimed as its province the entire field known as "strategic bombing." This is popularly supposed to mean the bombing of industrial objectives within a nation. But an anti-submarine strategy conceivably would include the bombing of anything and everything having to do with the putting of Russian submarines to sea.

It the Russian submarines prove to be as great a menance as many informed Naval officers believe they will, then a primary strategic-bombing objective should be the submarine lairs. Does the Air Force wish to reserve that field for itself only, to the exclusion of Naval air? Or does it think it may need a little help on the strategic bombing of the fringes of Russia—considering that it is committed, at least by its publicity, to the mass destruction of all Russian industry—in addition to affording air cover for an American Army, no mean assignment in itself? The Air Force, happily watching the Navy in a dither, should ask itself if it is not, in advance of war, biting off more than it can chew. After all, it can only grow so big. There are limits to what Congress will appropriate for air power, advertised as such. Would not the Air Force be wise to help build up more *actual air power* under the label of Naval Air—which is air power, too, though "baseically" different?

The problem is beyond the intelligence of the author, who contents himself with posing problems for wiser men to solve. Where are we to find those intelligences? We have

AEROTEC FLOAT SWITCHES...

Custom Built for

REPUBLIC'S LATEST JET FIGHTER

Republic's XF91 Interceptor utilizes 20 Aerotec Float Switches to assure dependable indication and control of propulsive fuels.

Aerotec's proved record of efficient automatic controls on the thousands of F47's and F84's that have been and are in service earned its consideration when the XF91 was in the development stage.

The XF91 is one of the galaxy of Navy and Air Force fighters that advantageously employ Aerotec's policy of designing a specific control for each individual problem.

Whether the application calls for float switches, valves, diaphragm or bellows pressure switches, Aerotec's representatives throughout the country, specially picked for their knowledge of the aircraft industry, are ready to offer assistance on any automatic aircraft control problem you may have.

Address all inquiries to The Thermix Corporation or the field engineer nearest you.

Project & Sales Engineers

THE THERMIX CORPORATION

Greenwich, Conn.

THE AEROTEC CORPORATION

GREENWICH CONNECTICUT

brilliant men in this nation. They are not all within the offices of the Joint Chiefs of Staff—or the Joint Chiefs would not have spent the last few months pushing each other around the joint.

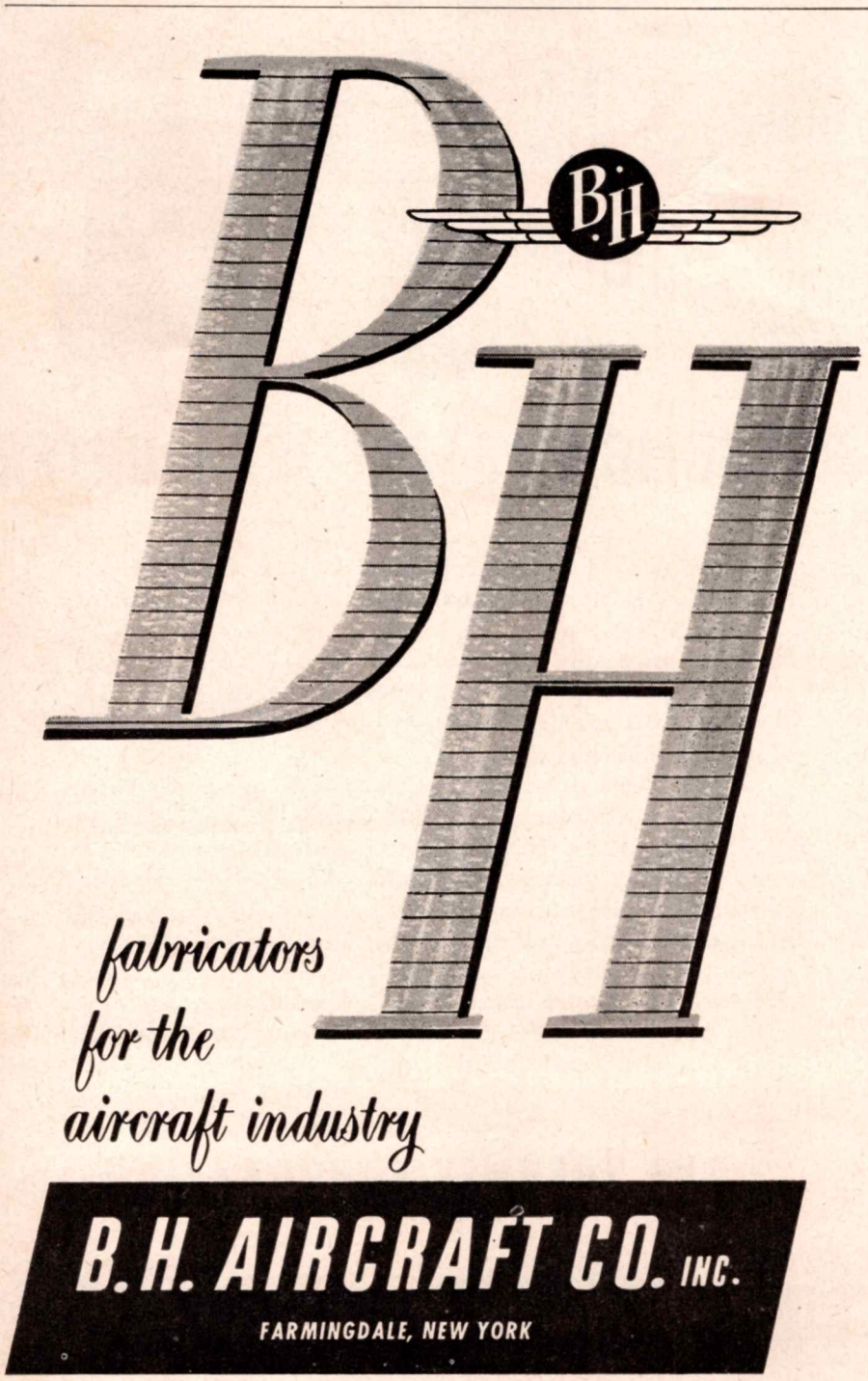
What we need—and this need should be obvious—is a small, compact collective Navy, Army, Air Force and CIVILIAN intelligence Perhaps the less civilian intelligence knows about the Army, the Navy, or the Air Force the better. If it is truly intelligent, it will be able to make the mental connections between this and that— a factor conspicuously missing in the past in the affairs of every nation engaged in the complex gamble of war.

I suggest—in all humility and personal bafflement and ignorance—the formation of a Federal War Advisory Panel, not to run a war, but merely to evaluate conflicting claims and ideas, and then to present those evaluations to the Joint Chiefs of Staff—also to the Armed Services Committee of Congress. Minority opinions of this group should not be set aside and ignored. The history of warfare in all ages has disclosed that only the minority was ever right, in a war, at any time. The majority almost invariably has been proved wrong by subsequent events.

Clemenceau said that war is too serious a matter to be entrusted to generals. He might have added it is too serious to be entrusted to navy men and airmen, as well. They have been conditioned by their professional lifetimes to see things from their professional standpoint. Their thinking is necessarily limited— though the geniuses among them surmount even that handicap, as geniuses in all walks of life normally do.

What we should seek is simply human intelligence in its highest brackets, so far as we may determine it. But who is to make the selection? Congress? . . . The President?? . . . the voters???

It's a losing fight!



JET SPEED

(Continued from page 23)

point out that the U. S. Air Force has in production, and in its combat units, the fastest jet fighters in the world, and that the first multi-jet bomber was flown here in America some two years before the first English multi-jet bomber became airborne.

Exclusive of aircraft still classified as secret, the U. S. has a total of 34 different types of jet aircraft flying, or being evaluated, as compared with the 24 jet-plane types shown by British at their recent annual aviation exhibition at Farnborough. However, all of our jet planes are military aircraft.

Our aircraft manufacturers have the know-how, the facilities and the desire to build jet airliners; and I am confident that every major airframe builder in this country has at least preliminary plans for jet airliners on his drawing boards. Only firm orders for these planes are needed to put plans into action.

There may be some advantage in waiting a little longer before starting on jet transports here in order that we may benefit from the experience of our English friends—but we should not be lulled into inaction too long by that pleasant theory. British jet planes should be ready to go on the airlines in limited numbers in from two to three years. If we started from scratch, it would take us from two to three years to build a prototype, about two years of flight testing and, atop that, another year of operational testing before it would be in regular airline service. About two years could be saved if we started from a miiltary model such as the Boeing B-47. We are now at least two years behind the British in jet-transport development and getting a day further behind every day.

The reason for our lack of development in the jet-transport field is largely one of money. The design, construction, and testing of any new plane is a risky and expensive undertaking—and it is doubly so in the case of a radically new type of plane such as the jet transport. The cost of this work has been estimated variously at between 20 to 40 million dollars. Our aircraft manufacturers cannot take a gamble of this magnitude, and neither can our airlines, individually or collectively, finance such an undertaking in their present fiscal conditions.

The military, the Governmental aviation agencies, the aircraft manufacturers, and the airlines should get together now—not tomorrow or next year—and work out a feasible plan whereby the construction of commercial jet prototypes may be started at the earliest possible date.

Failure to do this will, in my opinion,

seriously weaken our aircraft industry through deterioration of its position in world aviation markets, cause our airlines to be dependent on other countries for their planes and, most important of all, it will be detrimental to our national defense.

I have a deep interest in anything that affects our aviation industry, but I have a much deeper feeling—in this period of international uncertainty—for anything that materially affects our defense establishment. Should war come again, there will be a very great need for modern, fast and reliable transports. Reliability generally comes from long usage. In the past war, the most widely-used transport was one that had been flown for years by our airlines. Almost all of our wartime air-cargo tonnage was carried by planes originally conceived as civil passenger transports.

If it develops at the proposed meeting of the military, Governmental air agencies and the aircraft manufacturers and operators, that Governmental assistance is necessary—as I think it will be—for the design and construction of prototype jet transports, then a unified plan should be established at that time for obtaining and administrating the required finances in order that this important work can go forward immediately with a minimum of confusion and delay.

There exists considerable misunderstanding in the general public mind concerning the soundness of transportation subsidies and the invaluable contributions to our social and economic growth and to our defense which have resulted from the more rapid development of transportation through subsidy. It is fair to say, I believe, that all forms of transportation have benefited, and are still benefiting, either directly or indirectly, from subsidies.

Certainly we would not now have the worlds finest domestic and international airlines had it not been for the aid and encouragement they have received in the form of direct and indirect subsidies.

It is estimated variously that the railroads have received subsidies amounting up to a billion dollars or more in the form of land grants and other benefits. Two and a half billion dollars have been spent by the Government in the development and operation of our inland waterways, and our merchant marine has, since its inception—sometimes directly, and always through the provision of lighthouses and other aids to marine navigation—received Governmental aid. Public roads, on which to run, constitute an indirect subsidy to the bus line.

In none of these cases, in the past or in the present, has the principle of subsidies been bad. On the contrary, it has been good.

TURBOPROP CONTROLS

(Continued from page 39)

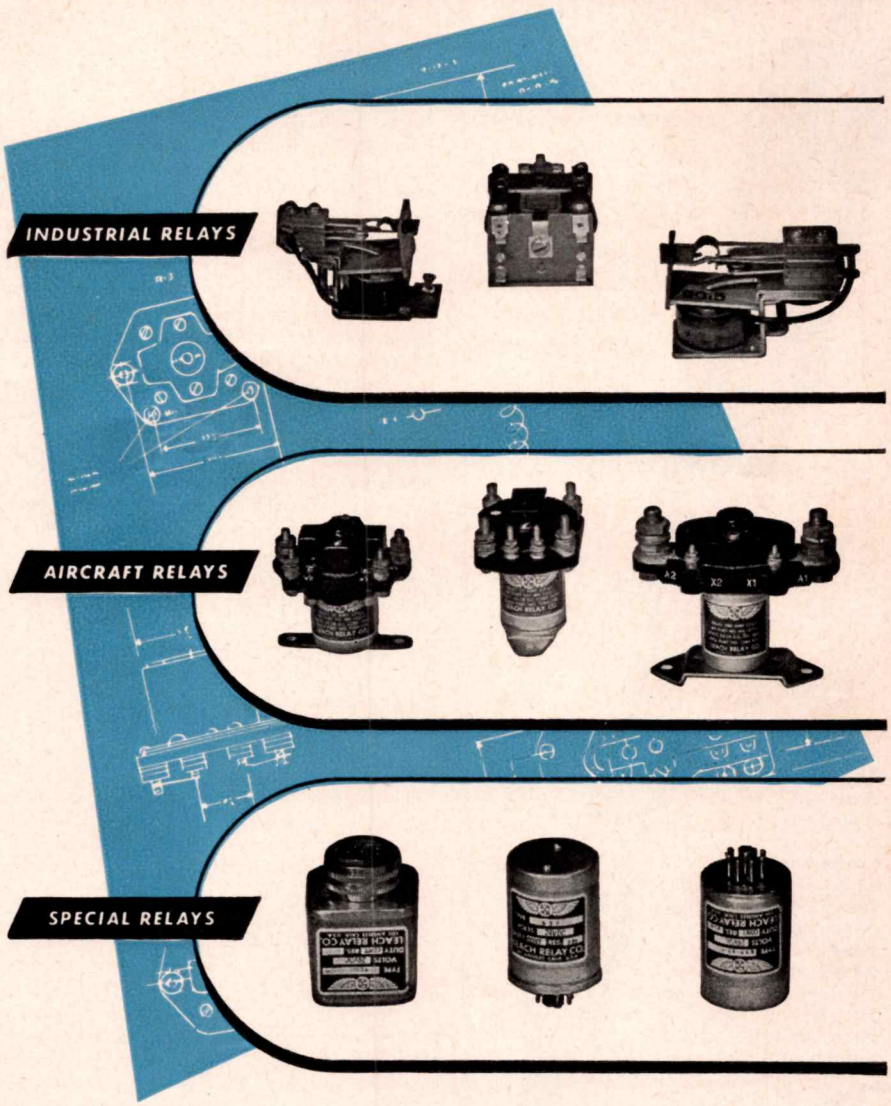
other lags—an assumption which in this instance has been found sound—the equation describing the action of the governor is:

$$(1 + \tau_s p)\Delta W_f = \frac{n_G}{p}(\Delta N_o - \Delta N) + k_D(\Delta N_o - \Delta N) \qquad (1)$$

In Eq. 1, the basic function of the term k_D is to reduce or eliminate the effect of a

Leach RELAYS

ARE PERFORMANCE PROVED!



You get better service from LEACH RELAYS because thousands of types of relays for thousands of applications have been proved-in-use for over 30 years.

LEACH RELAYS are designed with an exceptionally high factor of safety for *extra* dependability. Simplicity of designs makes installation quick, easy and inexpensive. Get *all* the facts and make your own comparisons. LEACH RELAYS' outstanding performance, reliability, sturdiness and economy have been *proved-in-use.*

Highest standards of engineering, materials and workmanship assure long, safe, efficient, trouble-free service.

FOR BETTER CONTROLS THROUGH BETTER RELAYS—CONTACT *LEACH*

LEACH RELAY CO.

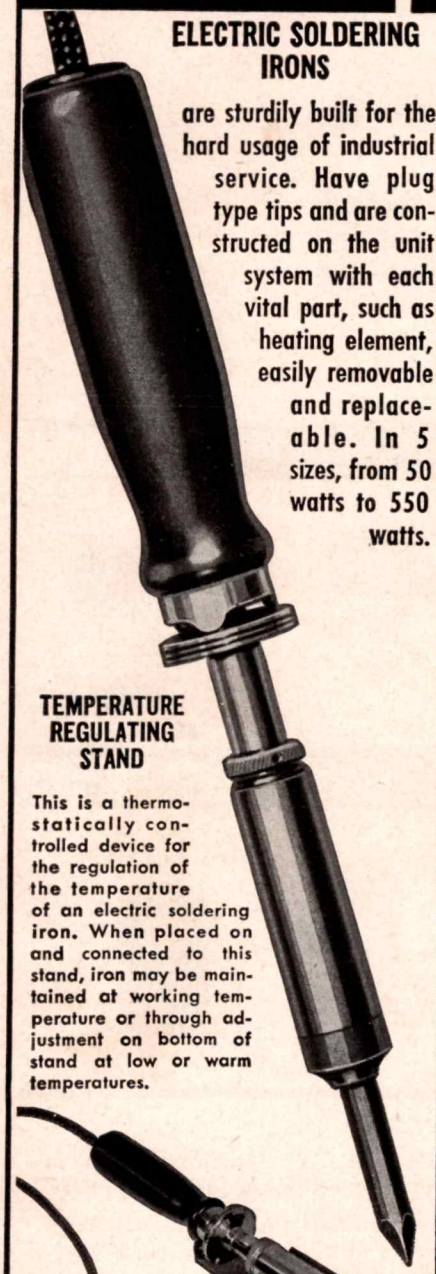
5915 AVALON BOULEVARD, ★ LOS ANGELES 3, CALIF.

Representatives in Principal Cities of U. S. and Canada

American Beauty

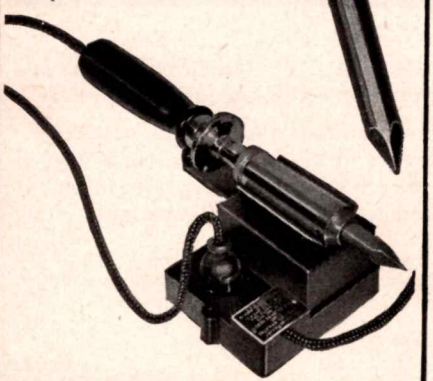
ELECTRIC SOLDERING IRONS

are sturdily built for the hard usage of industrial service. Have plug type tips and are constructed on the unit system with each vital part, such as heating element, easily removable and replaceable. In 5 sizes, from 50 watts to 550 watts.



TEMPERATURE REGULATING STAND

This is a thermostatically controlled device for the regulation of the temperature of an electric soldering iron. When placed on and connected to this stand, iron may be maintained at working temperature or through adjustment on bottom of stand at low or warm temperatures.



For descriptive literature write 110-1

AMERICAN ELECTRICAL HEATER COMPANY
DETROIT 2, MICH., U. S. A.

first-order exponential time lag. Since the largest time lag is the one which causes the most trouble in stabilizing the system, this is the one which should be cancelled out by the control. All of the significant time lags except the characteristic time of the turbine are in the control equipment, and presumably they may be kept within bounds by the designer, so that it should be unnecessary to compensate the control for any lags except the characteristic time of the powerplant.

Theoretically, this lag may be cancelled out completely by the proper section of k_D. Actually, however, this is not possible because of the large variations in lag which occur when flight conditions change. On one turbine studied, for example, the characteristic time was observed to vary between about .50 *sec* and 5.0 *sec* over the expected range of flight conditions.

Fortunately, only a few flight conditions—generally at high speed and low altitude—present a very serious stability problem. When the proper stabilization is applied for these conditions, it is found, in general, that all other conditions are also stable but that the control response becames considerably less rapid. Thus far, however, it has been possible to meet reasonable requirements of stability and speed of response with a single set of control sensitivities.

No lags exist in the indication of torque changes which are of a magnitude comparable with that of the *rpm* lag just described. Consequently, it has been found that a simple control equation can produce satisfactory power response when torque is the quantity to be controlled. The equation for a suitable torque control may be expressed as follows:

$$p\Delta\beta = n_Q\ (\Delta Q_o - \Delta Q) \qquad (2)$$

The same comments apply when temperature is the quantity to be controlled instead of torque, provided, of course, that the temperature pickup itself does not introduce an appreciable lag. Unfortunately, the development of rugged and reliable temperature indicators, which, when placed in the turbine combustion chamber, will provide a fast-responding temperature indication, has proved to be quite a problem. Means may be developed eventually to circumvent this difficulty, and it will then be found that the response of the complete system under temperature control is quite similar in nature to that under torque control. The corresponding alternative control equation would then be:

$$p\Delta\beta = n_T\ (\Delta T_o - \Delta T) \qquad (3)$$

The equations given above describe the action of the control equipment. In the response to changes of blade angle and fuel flow made by the controls, the powerplant reacts according to the following equations:

$$(1+\tau p)\,\Delta N = -a\Delta\beta + b\Delta w_f \qquad (4)$$

$$\Delta Q = c_Q\Delta W_f - d_Q\Delta N - \frac{c_Q\mu}{b}\,\tau p\Delta N \qquad (5)$$

$$\Delta T = c\Delta W_f - d\Delta N \qquad (6)$$

All the foregoing equations are something of a simplification of the practical case be-

Operation "EFFICIENCY"

EST. 1928
PAC
PACIFIC AIRMOTIVE CORP.
Burbank, Calif.
PAA

WE'RE KNOWN BY THE COMPANY WE KEEP!

Pan American . . . *the world's most experienced airline* demands dependability in all phases of its operations. That's why PAA chose Pacific Airmotive to serve its far-flung empire ...an association of 15 years duration.

This is indeed proud company! When PAA...*world's most experienced airline* combines with PAC...*world's most experienced Engine Overhaul & Supply House* . . . the net result — "OPERATION EFFICIENCY"

PACIFIC AIRMOTIVE CORP.
Burbank, California
OTHER MAJOR DIVISIONS
LINDEN, N. J. • KANSAS CITY, KANS.
OAKLAND • SEATTLE • ANCHORAGE

cause they assume a linear system. Actually, such quantities as the rate of change of equilibrium *rpm* with blade angle show a wide variation when the entire range of propeller blade angle is considered. The same applies in greater or less degree to most of the other coefficients in equations. However, when disturbances are small, the assumption of linearity is justified. Thus the stability characteristics of the system around its steady-state operating point may be studied by use of such a set of equations, provided that the coefficients are individually determined for each operating condition to be studied.

The response of the system to the large disturbances with which the actual controls sometimes will have to cope will differ from the solution of these differential equations. But the difference is primarily in the initial part of the transient, so that, while the time required for the system to respond to a disturbance may differ somewhat from the analytical results, the character of the response— *i. e.*, whether the system is stable or unstable, or whether it is over-damped or under-damped—should be essentially correct.

The presence of dead zone in the controls themselves is not taken into account in the equations, but this shortcoming may be dealt with satisfactorily by means which will be described later.

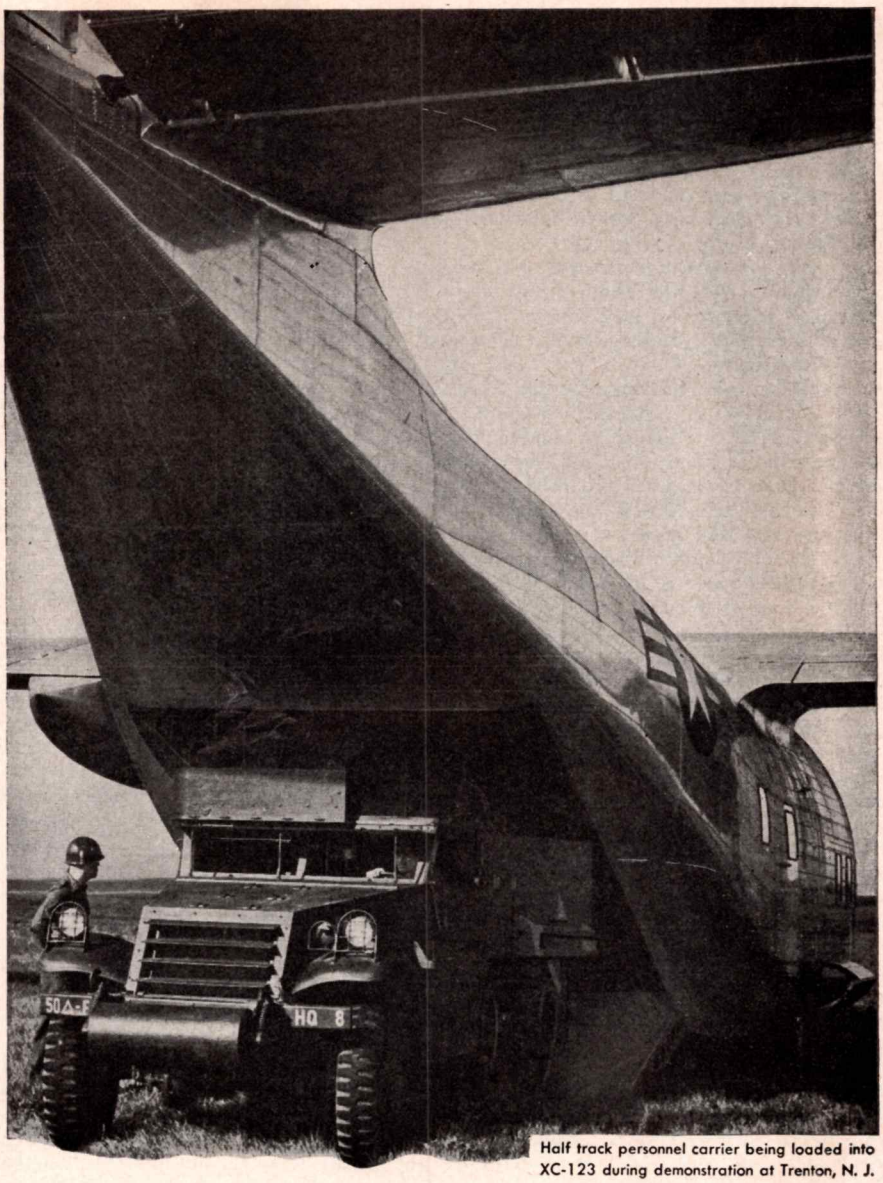
The torque response equation *(Eq. 5)* indicates the torque supplied by the turbine and measured at the propeller shaft. The last term of the equation represents the torque absorbed by the turbine and compressor during acceleration.

Because of the interaction of one automatic control with the other, it is necessary to select the control parameters on the basis of a study of the entire system rather than merely by considering each control separately. The equations may readily be solved simultaneously to yield, in the case given above a fourth order linear differential equation in N and another similar one in T or Q.

At this point, an analog computer is of inestimable value. The individual differential equations which describe the behavior of the system may be set up separately without mathematical manipulation and solved simultaneously by the machine. The results appear as plots of the response of the system to any desired type of disturbance such as a sudden change in power setting or a gradual change of *rpm* setting.

The electronic differential analyzer is also of great value at a later stage in the development program. Transducers may be built which convert the electrical signals corresponding with torque or *rpm*, for example, into quantities which serve as the inputs to the actual controls. Thus, as the control equipment becomes available, real apparatus may take the place of the control differential equations one by one so that the actual characteristics of the control equipment may be studied at small expense, under conveniently controlled laboratory conditions, and at no risk to personnel or expensive developmental powerplants or airplanes.

Description of an Actual System.— In the course of the studies preceding the design of a control system, it became apparent increasingly that the governor should have primary reliability. It appears that, if



Half track personnel carrier being loaded into XC-123 during demonstration at Trenton, N. J.

UTILITY

Whether crated vehicles or a huge half-track personnel carrier; hay for marooned livestock or litters for evacuation of wounded; transport of replacement troops to forward areas or paratroops to jump areas— loading and unloading will be simple—safe, speedy delivery assured.

Chase AIRCRAFT CO., Inc.
WEST TRENTON, NEW JERSEY
STROUKOFF AVITRUC

necessary, power may be controlled manually by the pilot; but *rpm* control by manual adjustment is unsatisfactory because of the large, sluggish *rpm* drifts which, under many conditions, follow a small adjustment of blade angle or of a manual fuel control. Under some conditions, manual *rpm* control has even been found to be unstable.

Hydraulic governors which incorporate stabilization of the needed type are available, and a modified Woodward governor was found to meet the requirements satisfactorily. The governor may be seen in the general view of the turbine-mounted control unit shown in *fig. 3.* It is fitted with an electronically controlled speed-setting head. This overcomes the difficulty in setting speeds accurately through a mechanical linkage from a pilot which may be some distance from the governor. It does not reduce the basic reliability of the mechanical governor materially, since, in the event of electrical-supply failure, the governor continues to hold speed at the value called for it at the time of failure.

The remote control fulfills another essential function in causing changes in speed setting to be made slowly. It is a characteristic of governors of this type to cause a large, sudden increase of fuel flow when speed setting is increased suddenly. This is not permissible in a turbine, since, in accelerating from low *rpm*, very serious over-temperatures would result. The remote control is designed, therefore, so that the rate at which *rpm* setting can be changed matches the rate at which the turbine can accelerate safely.

The design of the power control avoids the problem of finding a means of measuring turbine temperature reliably and rapidly by the expedient of controlling torque instead of temperature. At any one flight condition and *rpm*, it has been observed that torque varies almost linearly with temperature. The torque at which maximum temperature is reached, however, varies over as much as a four-to-one range, depending on flight conditions.

It is possible however, to make a computer *(fig. 4)* which recognizes flight conditions from such measurements as ram pressure, ambient pressure and temperature, and which determines with fair accuracy the torque which results in maximum-permissible temperature at any flight condition. Because of the relative complexity of the empirical equation which the computer is to solve, and the anticipated need for flexibility in matching the characteristics of other turbines, electronic means were employed.

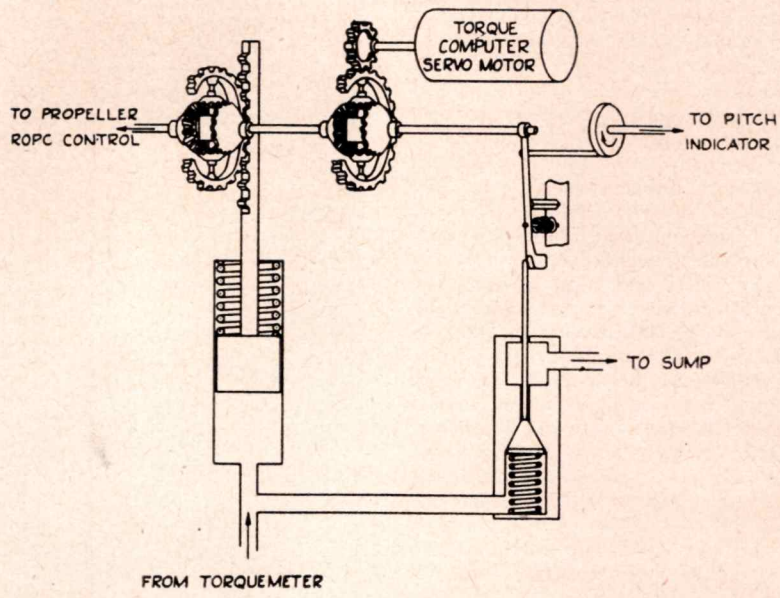


Figure 5

Use of torque control instead of temperature control eliminates the problem of shifting the control from temperature to torque at the minimum-power position of the power lever. It also simplifies the problem of torque limiting, since, whenever the computer indicates that an excessive torque is obtainable before maximum temperature is reached, it is a simple matter to disconnect the computer automatically from the control and connect a fixed signal, representing maximum-permissible shaft torque, instead. The pilot's power lever then merely selects the desire percentage of currently available torque.

Since torque, rather than temperature, is being controlled, an interlock is provided so that, when an *rpm* increase is called for, the demand for more torque, also made when the power lever is advanced, is deferred until the *rpm* change is completed. Without such an interlock, the torque load on the turbine would increase rapidly, causing the over-temperature, since the *rpm* would not yet have reached the point when the increased torque called for would be available.

The signal from the torque computer, as modified by the pilot's power lever setting, is transmitted to a positioning servo in the turbine-mounted control unit. The gearing arrangement in this unit is shown schematically in *fig 5.* An indication of the torque being developed is obtained from a spring-restored piston position by the pressure from the turbine's hydraulic torquemeter.

The indication of torque called for is applied to the ring gear of a differential, which has one of its sun gears normally locked, so that the signal is transmitted unchanged into the sun gear of a second differential. The ring gear of this differential receives the indication of the torque being obtained so that the output of the second differential is proportional to torque error. This signal is then transmitted to the control shaft of a propeller with a continuously controllable rate of pitch change. The propeller control thus fulfills the requirements of *Eq. 2.*

Since the torquemeter is incapable of registering negative torque, the computer is adjusted to call for a minimum torque slightly above zero. This enables the control to remove any over-correction which might occur when reducing power. At very low forward speeds and a standstill, torque control becomes impossible at minimum power setting, as explained previously.

Under these conditions a manual control of blade angle overrides the torque control. Blade angle decreases as the propeller tries to find a blade angle which will fulfill the torque requirements. A mechanical pitch indicator is connected with the control and, when the blade angle has decreased to a predetermined value, the pitch indication is applied to the normally fixed sun gear of the first differential in a direction to prevent a further decrease of pitch. The blade-angle setting at which this so-called *beta control* comes into action is a compromise between the zero thrust angle at standstill and the angle at which the torquemeter loss control occurs, at forward speeds.

Movement of the power lever beyond the minimum power setting into the reserve range sets the positioning servo proportionately below the minimum torque setting. Blade angle then decreases until it is a stopped by the action of the pitch indicator, so that the power level becames a direct control of blade angle in the reverse range. The torquemeter is bypassed when the propeller is in reverse, so that the blade angle setting is unaffected by the increasing torque ob-

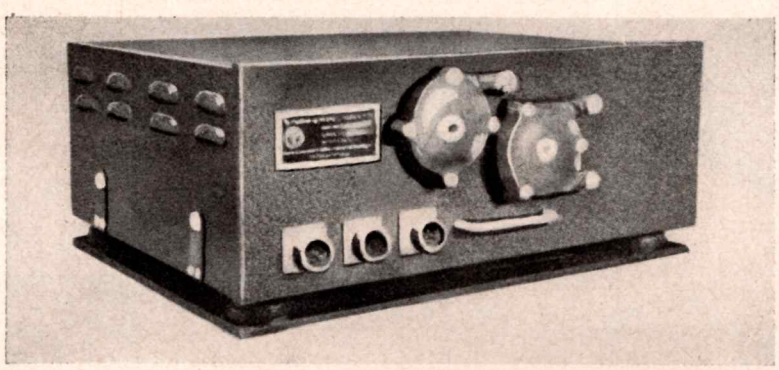


Figure 4

tained as the propeller decreases pitch. The reverse blade-angle limit is set low enough so that the power rating of the turbine is never exceeded, which setting nevertheless provides ample reverse thrust under any condition.

When the condition lever is in the *Start* position, the positioning servo is set slightly below the zero torque setting to insure that the propeller will receive a decrease-pitch signal until the proper starting blade angle is reached. Fuel is controlled manually by a third lever on the quadrant until the turbine reaches the ground-idle speed, at which point the governor takes over control.

In the *Stop* condition the positioning servo is set to the maximum torque setting and the fuel is cut off. The propeller then feathers at the maximum-permissible rate; that is, the rate which just causes torque to approach the limit established for the reduction gearing.

FIRE AND RESCUE

(Continued from page 58)

natural knowledge and training to do the right thing.

A great deal of equipment in common use can be employed effectively in rescue operations. But the tools must be available in one kit—right there when needed—and they must be used by trained personnel. Ingenuity, planning and training can create an orderly, effective rescue facility which otherwise might result in chaos after a plane crashes on or near a field.

Suitable equipment can be secured cheaply in hardware and war-surplus stores. The larger airports, where air-transport operations are common, have separate problems varying with size of aircraft, terrain and many other factors.

The very minimum to be provided by way of protective clothing for crash crews at small airports is a pair of long, strong leather or wool gloves with leather lining. They prevent hands, wrists and forearms from being burned or cut by jagged metal or broken glass. Gloves delay the chance of hands being burned and extend the time that the crew can use its hands effectively. Boots are about as important as gloves. The extremities are most frequently in contact with hot surfaces. A hood, of course, is practically a must.

Asbestos clothing is *passe* — no longer recommended because it bakes the occupant. Heavy woolen shirts and trousers are desirable, but bulky clothing may restrict freedom of action and requires too much time to put on. A fireman's bunker suit and boots are very desirable. Your local fire department might provide you with protective clothing in return for assistance when automobiles crash nearby or neighboring houses catch fire.

Whether or not the men are provided with protective clothing, they will need other tools. Occupants of small aircraft often are trapped by structural members; cables entangle their legs or lock the controls firmly against their bodies. Rudder pedals may trap them by the ankles. A broken arm may prevent unfastening of safety belts.

Pinch bars, cable cutters, flashlights, searchlights, metal shears, bolt clippers, a small hatchet, hacksaws, an axe, a sharp knife, and screw drivers are required. Heavy pliers, to crimp leaking fuel lines or to pull on wires or tubes, should be at hand. Long-handled shovels and a pike may be useful to get under an overturned plane to loosen the canopy. Several heavy woolen blankets may be used to provide temporary protection against radiant heat and fire. Asbestos blankets are better. First-aid kits should be at hand.

A large tank of water (25 gallons) and a pump for wetting down rescue personnel seems like desirable equipment. I am assuming that pumpers and large tank trucks are beyond the means of most small airports. If they were within your means, fog nozzles should be used.

A grappling hook with at least 50 *ft* of chain should be in the crash car to help in moving burning wreckage, possibly from over a pilot. Portable CO_2, dry-powder or Pyrene extinguishers should be carried.

Do not get too much equipment, so elaborate that it requires professional firemen to maintain. Overloading is undesirable; the object is to have a minimum of necessary tools available to men who know how to use them.

After you have the tools and, preferably, at least two well-trained men who drill at least once per month—as many other em-

Here's Proof of the Superior SHOCK RESISTANCE of FRONTIER 40-E ALUMINUM ALLOY!

In both experimental test and actual service, FRONTIER 40-E—a non-heat-treated aluminum alloy—has shown exceptional ability to withstand direct or transmitted shock.

This and other special properties enable FRONTIER 40-E Aluminum Alloy to give outstanding performance in a host of applications throughout the aircraft industry.

Following Test Data show the superior shock resistance of FRONTIER 40-E:

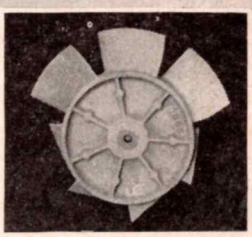
TEST: 95-lb. ball dropped 42 in. onto 40-E casting and castings made from other alloys.

CASTINGS USED

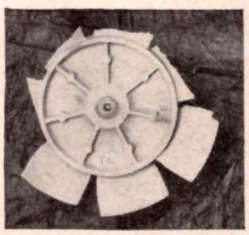
	PROPERTIES		
SYMBOL	Yield Psi.	Tensile psi.	% Elong. in 2"
1-T6	20,000	34,000	* 3.0*
2-T6	24,000	32,300	1.5
Frontier 40-E	24,300	33,000	4.5

* Broke outside gage marks

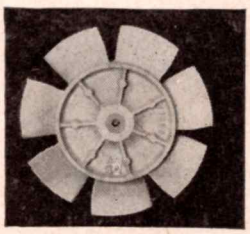
RESULTS: As shown in photographs at right.



1-T6 Casting After Test

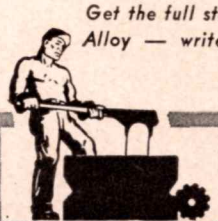


2-T6 Casting After Test



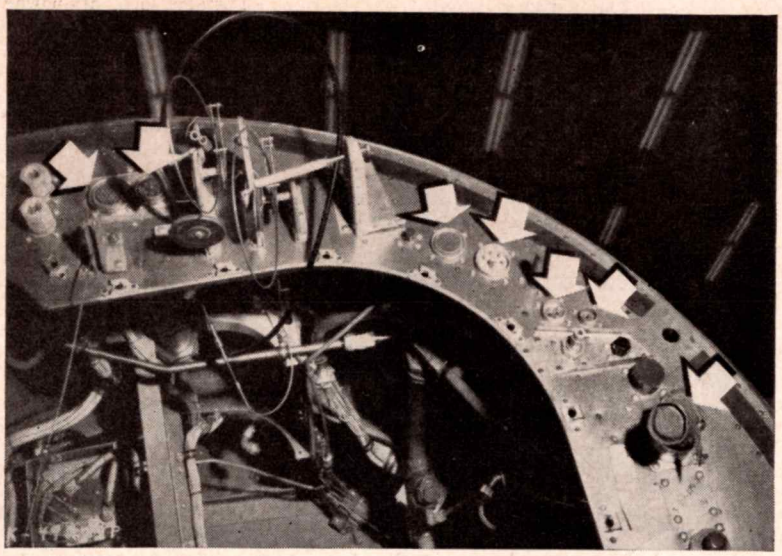
Frontier 40-E Casting After Test

Get the full story of Frontier 40-E Aluminum Alloy — write for free Data Book today!

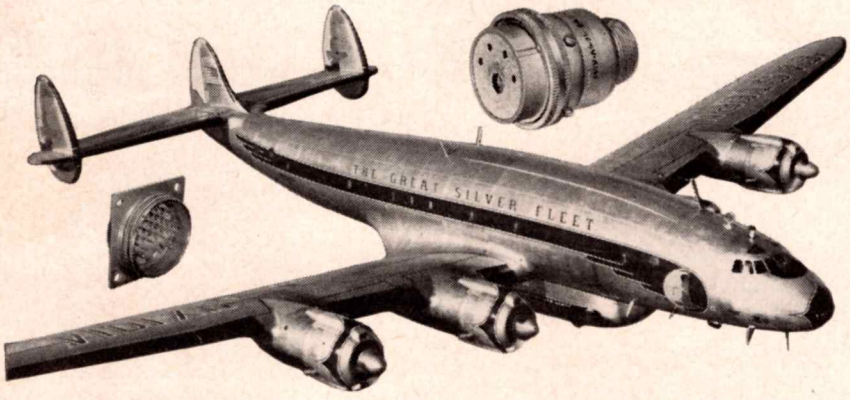


FRONTIER BRONZE CORPORATION
4880 PACKARD ROAD, NIAGARA FALLS, NEW YORK

LOCKHEED CONSTELLATIONS ARE PROTECTED by CANNON FIREWALL PLUGS



Arrows point to several Cannon Type K Firewall Connectors on portion of Constellation Engine Firewall. Included are Flame Barrier and Fireproof Types.



Just as Cannon Electric pioneered and developed the standard multiple-circuit electric connector for the aircraft industry back in the 30s, Cannon also was first to meet the requirements of the aircraft manufacturers and airlines under CAA regulations for engine firewall or bulkhead fireproofing toward the greater safety in air travel.

Cannon Firewall Connectors, whether in the "K", "RK" or "FW" (AN) series are made in two fundamental types: Flame Barrier and Fireproof. Both types have steel shells and are used with steel conduit. The main difference is the material of the insulators, and type of contacts.

Complete information on Cannon Firewall Connectors is given in ANF Bulletin and the Firewall Section of the K3 Bulletin. Both will be sent gratis upon request.

Address Cannon Electric Development Company, Division of Cannon Manufacturing Corporation, 3209 Humboldt St., Los Angeles 31, California. In Canada: Cannon Electric Company, Ltd., Toronto. World Export: Frazar & Hansen, San Francisco, Los Angeles, New York.

SINCE 1915

CANNON ELECTRIC

REG. U.S. PAT. OFF.

ployees as possible should be trained—you are faced next with the problem of providing them with a reliable means of getting to a crash in a matter of seconds. Time lost cannot be regained; speed is essential to efficiency.

Some small airplanes have a good history of fire delay following a crash. It may be possible for a fast and efficient crew to get to a crash before a fire occurs. If you can afford a "jeep," its high ground clearance and good traction make it far preferable to an automobile or ordinary truck. But, if you must revert to a car, an old one is better than a new, modern one because of higher ground clearances.

Old used cars are relatively cheap. Mechanics can put them in good running condition. The vehicle should be maintained for instant operation in all seasons of the year; it should have the rescue equipment inside or on a trailer for quick attachment. The driver should be familiar with the field, knowing all the soft spots, holes, trenches. He should be able to get to any part of the airport within 60 seconds after the alarm.

At some times of the year, snow may interfere with use of the vehicle. Chains should be on the wheels. You may not be able to provide for all contingencies. Do the best you can with whatever funds and planning ability and ingenuity you have.

The vehicle should be provided with a siren to sound the call for all to come to help. Another siren should be near the gas pump or other accessible point; they can be hand-operated. Even an old-fashioned iron fire ring is better than nothing, especially if the alarm is to be heard above an engine running nearby. The office phone and the phone booth should have the telephone numbers of the local fire department, police, hospital or doctor posted nearby. Some one should be made responsible to notify these agencies and to stick by until it is certain they are notified.

For fire-extinguishing mediums, small airports limited by funds must choose between foam, high pressure CO_2, dry powder, perhaps fog. Discussing their relative merits is like discussing religion and, like religion, they are all good if used properly.

Foam applied over dry powder is said to be unsatisfactory; the bubbles of CO_2 in the powder break the foam blanket. Water following foam is not good. The water washes the foam away. Foam is not as effective as CO_2 on running gasoline fires. The protective blanket that foam provides can be broken by heat—hence large quantities of foam are required. In quantity it is highly effective. Dry powder has advantages over high-pressure CO_2 because it can be directed with greater accuracy over longer distances, especially in a wind.

A combination of extinguishers is better than one; foam for blanketing; water-fog for cooling men or hot metal but generally not for fighting gasoline fires; CO_2 for extinguishing fires in concealed pockets or running fires. They all are satisfactory when used by trained personnel and in sufficient quantity.

If your rescue operation is successful, the survivors will be sent to a hospital. Do you know whether your nearest hospital is prepared to cope with the kind of emergency that occurs when an airplane crashes?

Airports adjacent to bodies of water have

a problem of off-shore rescue if an airplane overshoots. (See "Problems of Offshore Rescue," AERO DIGEST, Dec. 1949).

The equipment for crash rescue need not be expensive. Manpower should be available. Training and drills can be conducted in coperation with local fire departments or perhaps at a nearby Air Force base.

The cost of adequate equipment presents a challenge to the purse, of course—and to ingenuity and conscience as well.

46 YEARS YOUNG

(Continued from page 18)

individual—this time to the Radio Technical Commission for Aeronautics for the All-Weather Air Traffic Control System recommended by its *Special Committee 31,* and adopted by the Air Coordinating Committee (AERO DIGEST, April 1949.).

The RTCA is a cooperative association of all Government and industry telecommunications agencies, which conducts studies of related aeronautical problems. Its object is the resolution of such problems by mutual agreement, and their findings are submitted to all organizations concerned as a joint recommendation.

In April 1947, the Air Coordinating Committee requested RTCA to undertake a study of air-traffic control for the purpose of developing such recommendations. In accordance with this request, a Special Committee designated *SC-31—Air Traffic Control* was established in June of that year. Its work was divided into two phases: Phase I, the development of basic air-traffic control principles; Phase II, the development of recommendations regarding equipment and procedures required to implement these principles.

On Feb. 17, 1948, Special Committee 31 presented its report to RTCA and, on May 12, RTCA issued the approved report and forwarded it to the Air Coordinating Committee in fulfillment of its request of one year before. In less than two months, the report had been adopted by the ACC, the Research and Development Board and both the Presidential and the Congressional Air Policy Boards. The ACC immediately proceeded to set up a panel of engineers to draw up equipment specifications and to let manufacturing contracts (AERO DIGEST, Sept. 1949).

Briefly, RTCA recommendations are as follows:

(1) The Need.—All aircraft in any region must be accounted for, for the good of national defense and safety. Integration of air-traffic control and a navigation system with the air-defense and early-warning system will solve the military problem. At 13 airline stations, studies of congestion in air traffic were shown to have caused airline losses of over 39 million dollars, when bad-weather cancellations and low load factors resulting from unreliability were considered.

(2) The Present Situation. — Existing techniques of traffic control have proved their inability to handle the present volume of air traffic, particularly under adverse weather conditions.

(3) The Cure.—Such a system must consolidate into a single equipment all of the services required for navigation and instrument landing, radio communication for traffic control, and a map-like picture which furnishes a navigation check to the pilot and gives him a means to monitor the traffic situation and movements of other aircraft in his vicinity.

(4) The Cost.—The cost of the entire system is estimated at a little over a billion dollars.

(5) The Execution of the Program.—The program requires some 15 years for complete development, installation and training of operators. Meanwhile, an immediate interim program is proposed, to be completely installed and operating within five years. This should comprise a low-cost, lightweight VHF receiver, permitting the use of static-free voice channels and omni-directional range navigation on small aircraft. (AERO DIGEST, Jan. 1949).

(5) A VHF/ADF at airports is recommended, and also a simple mechanical-interlock board to assist harassed traffic controllers and tower operators. The cost of the interim program is estimated to be 375 million dollars, of which 2% is for completion of development of this equipment.

The Committee found that, "the time and monies required could be decreased substantially if development contracts could be permitted to run for a period of five years instead of the present two-year limitation." Also, "time for the full implementation of the RTCA system should be reduced materially by a revision of present contractual policies."

LINK FOR THE JETS

(Continued from page 37)

instructor's console. This traces a true ground path on an actual Radio Direction-Finding Chart, 22 *in* square. The check pilot can set or reset the pen at any point by means of a manual drive.

The embryo jet pilot discovers that airspeed is associated with Mach number, and he learns that if Mach .8 is exceeded in this "aircraft" it becomes disabled. He becomes conscious of *G* forces indicated on the accelerometer, and learns to watch *rpm* and tailpipe temperature, mindful that a hot tailpipe must be corrected within a matter of seconds or the engine will fail. With all this realism, it frequently is difficult to remember that the trainer is stationary on solid ground.

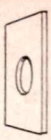
The Link Jet Trainer is 14 *ft* long; weighs 3750 *lbs;* occupies less than 100 *sq ft* of floor space. Though it does not move, it provides complete flight realism including 360° aerobatics about three axes, along with the effects of wind, rough air, thunderstorms and lightning.

"Fuel consumption" of the *Linktronic*

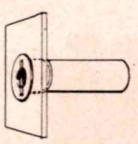
DILL
LOK-SKRU
•• THE BLIND
Anchor Nut
or
Rivet

Complete Installation in Seconds

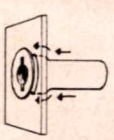
1 Drill one (1) hole.



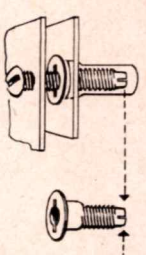
2 Insert Lok-Skru with either Hand or Power Lok-Skru Tool.



3 With Lok-Skru Tool draw barrel over shoulder of Lok-Skru and flush with metal. This provides a Blind Anchor Nut for Secondary Attachments.



4 TO FASTEN ATTACHMENTS insert standard Machine Screw through hole in attachment and into Lok-Skru. As machine screw is tightened into Lok-Skru it is securely locked by means of the "Specially Crimped" locking-end of the Lok-Skru.



Crimped internal threads of Lok-Skru provide secure locking device for attachment screw.

THE AVIATION STANDARD

for Screw Locking Anchor Nut Uses and Metal to Metal Fastening.

Write for Folder

Handy information on the many uses and application of Lok-Skrus in airplane construction with complete data on types and sizes.

THE DILL MANUFACTURING COMPANY

FACTORY
700 East 82nd St.
Cleveland 3, Ohio

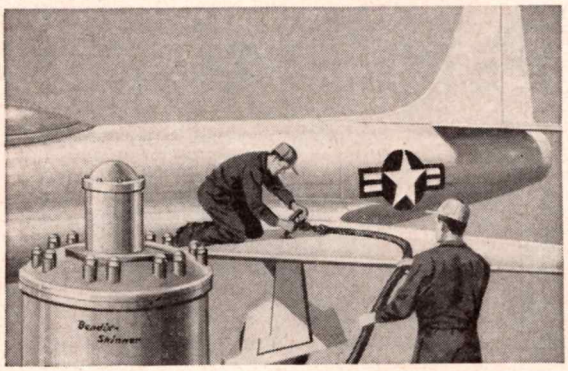
BRANCH
1011 S. Flower St.
Los Angeles 15, Calif.

Bendix-Skinner

ORIGINATOR OF **MICRONIC** FILTRATION

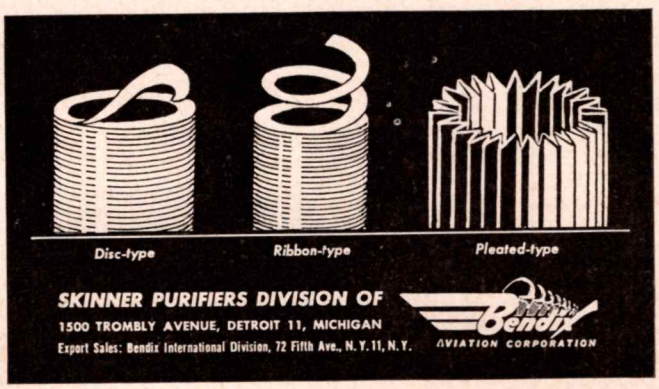
Results Prove It

the *Finest* Name in Filtering



Whenever there can be no uncertainty about fineness of filtration, rate of flow or filter collapse, ***Bendix-Skinner*** gets the call. In fact, ***Bendix-Skinner*** has been handling the hardest jobs for over twenty years. From this experience have come new and exclusive filtering techniques that assure better performance on any job, *nine times out of ten.* Write for details of the filters backed by Bendix and built by Skinner.

***Over 350 Models** providing filtration from ½ micron (.000019") upwards at flow rates from 1 to 5000 g.p.m.*



SKINNER PURIFIERS DIVISION OF
1500 TROMBLY AVENUE, DETROIT 11, MICHIGAN
Export Sales: Bendix International Division, 72 Fifth Ave., N. Y. 11, N. Y.

Bendix AVIATION CORPORATION

amounts to about six or seven K.V.A. of 220-*v* electric current per hour. From a design standpoint, this newest Link is a far cry from the old pitch-bank-and-bellows trainers. The Jet contains 242 electronic tubes and has more than eight miles of wire.

Once a pilot has disabled his "aircraft" by exceeding *G* forces of Mach number, he cannot prevent the uncontrollable spin which ends with a blast of the warning horn as his hypothetical plane crashes into the ground. In an airplane this would necessitate an attempt at bail-out; in the Trainer it can be corrected by a touch of the instructor's finger on an "Engine-Aircraft Reset" switch.

It is essentially an electronic device, based upon a series of aerodynamic equations which express all the essentials of jet flight. Electronic computers were designed to solve these equations continuously as their values are changed by such physical inputs as control positions, altitude and throttle settings.

The computers express the changing solutions in voltages which, in turn, are fed through amplifiers and servos and finally presented to the pilot as instrument indications, control pressures and radio signals. There are 24 computers in all, housed in cabinets at the base of the Trainer. To achieve maximum utilization by the Air Force, the Trainer has been made easily portable by mounting it on castered wheels and its disassembly has been made possible into four sections, small enough to pass through a normal door.

Ready access to the electronic equipment is provided by separate chassis units, rolled out on their mountings for inspection purposes. Complete removal for maintenance is accomplished through hand-release fasteners and quick-disconnect plugs for electrical connections. Minor adjustments and operational checks can be made while a flight problem is in progress.

The prototype has undergone extensive tests at Wright Field and was accepted for use by the Training Command. It is designed to simulate procedures inherent in such jets as the Lockheed F-80 and Republic F-84. However, for each specific change in aircraft—the North American F-86, for example—some of the electronic computing units must be changed to conform with a new set of performance characteristics.

AIR CARGO—1950

(Continued from page 35)

Transatlantic air-cargo service was established first in February 1946, when Trans World Airline inaugurated the service to Paris, Rome and Cairo. Although British Overseas Airways had inaugurated Atlantic service in August 1938 and Pan American in May 1939, only express was carried.

It may be well, at this juncture, to clear up some points in terminology. *Air Express* refers to shipments traveling via facilities of the Air Express Division of the Railway Express Agency, a railroad-owned entity. *Air Freight* originally was so classified by the Armed Forces, and was used to distinguish all shipments not being transported by REA. *Air Cargo* is the word combination standardized by the International Air Transport Association to replace "air freight," in meaning any material transported on the carriers'

own airwaybill, as differentiated from shipments carried by the airlines under contract to REA, which move on the REA waybill. In the annual report of the Military Air Transport Service for 1949, it is noted that the term "air cargo" is now being used also by the military.

To get back to 1946: returning military airmen, having participated in the incredible freight operations of ATC, NATS, Air Service Command and Troop Carrier Command, were unable to secure cargo positions with the scheduled airlines which, owing to lack of past foresight and current equipment, were unable to do much more at the time than struggle with facilities for passenger travel. As a consequence, veterans organized some 200 non-scheduled air-cargo lines, hiring others of their experience to work with them.

Such cargo operations based on charter and contract rather than fixed schedules, were comparatively new to air transportation in the U. S. For seventeen years the scheduled airlines had exclusive contracts with the Railway Express Agency's Air Express Division, which effectively prohibited entrance of volume cargo into the air-transportation picture. However, in March 1943, the Civil Aeronautics Board promulgated an order permitting these contracts to be revised to permit the airlines to conduct cargo as well as express operations.

Although these airlines had reduced their cargo rates by about 50% under the prewar air-express rates and had provided a few all-cargo schedules, the timid toe they had dipped into the pool of air-cargo possibilities left too much to be desired by shippers who were anxious to avail themselves of air speed for reconversion needs and the establishment of new enterprises. Therefore, the non-scheduled air-cargo lines were almost literally swamped with orders. One pioneer cargo line was forced to turn down less-than-planeload orders and restrict its operation to 5000-*lb*, full-plane loads!

Then the scheduled airlines woke up! Or at least *some* of them did. Others became so chagrined at having been "beaten to the punch" that they set the wheels of politics in motion to force these "upstarts" out of the picture, using the bewhiskered "grandfather clause" of the Civil Aeronautics Act as one angle. This didn't work too well, but one other of their angles did. The airlines had a wealth of finances behind them—at least in comparison with the non-scheduled lines, which were started mostly by veterans with their wartime savings and GI business loans. So, the scheduled airlines initiated legal action, both in the courts and with the Civil Aeronautics Board.

Hamstrung by lack of funds, personnel and precedents, the CAB was unable to cope with the situation, and the long-drawn-out, agonizingly slow process of law froze out all but the strongest of these non-scheduled companies. Restrictive legislation was promulgated piecemeal, and many non-scheduled lines went bankrupt since they couldn't fight the scheduled lines, comply with CAB regulations and efficiently serve their customers, all at the same time, for any length of time, on their budgets.

However, a few of the strongest of the "non-skeds," as they are called familiarly, were able financially to withstand the attack. In August 1949, the CAB issued a final

They Use PACIFIC-WESTERN GEAR ENGINEERING

Virtually all manufacturers of commercial and military aircraft use Pacific-Western gear engineering or production facilities.

• • •

FOR AIRBORNE EQUIPMENT such as rotary, linear, and cable-drum actuators, airborne hoists, special assemblies, accessory drives and drive shafts, precision-quality aircraft gearing, special parts...

FOR TESTING EQUIPMENT such as power-on models, wind-tunnel drives, wind-tunnel gears, special high-speed gear units...

FOR GROUND-HANDLING AND PLANT EQUIPMENT such as hoists, speed reducers, special transmissions, variable-speed drives.

For all kinds of geared aircraft products, take advantage of Western Gear Works' outstanding engineering and production facilities.

Write, wire or phone Western Gear Works • Box 192
Lynwood, California • Telephone Nevada 6-2161

plants at Seattle San Francisco Los Angeles

PACIFIC GEAR & TOOL WORKS ⚙ WESTERN GEAR WORKS

AGMA MEMBER

PACIFIC-WESTERN

4916

GEAR PRODUCTS

Airplanes . . . C47 ... C54 ... B26 ... DC3

Exceptionally Low Time

1 ea. DC-3 TOTAL TIME ONLY 401:00 hours; 24 VOLT ELECTRICAL SYSTEM
BRAND NEW 1830-92 ENGINES

Mfg. for Airline, Military Release, Licensing now in Process; Airline Type Radio - Interior to Suit - Price $65,000
1 ea. C-47-A Cargo T.T. 2912:00 Hrs. NTSO 1830 Engs., New Tires, Brakes, Batteries Props. Plane Now in Process of Lic. Radio: Collins Art-13, Bendix RA-10, Arn-7, Marker Rec., Auto Pilot. Let Down Door Available if Desired . . $29,500
1 ea. C-47-A Cargo T.T. 2281: Hrs. Bal. Same as Above . . . $29,500
1 ea. B-26-C Martin Low Time, Long Range Tanks. Flyaway . . . $12,000
5 Pr. C-54-D Outer Wing Panels, Very Good Condition . . . . Pr. $16,000
5 ea. Towers - Blaw Knox 125' Radio Towers Complete . . for set of 5 $6,000
1 ea. C-54-A Nose Section, Front 200" Good Condition . . . $5,000
New 1830-43/65 P & W Engines $1,250
NTSO 1830-43/65 Engine $600.00

Radio: Collins Art-13; 0-16/LFO; C-166 Jack Box; ARC-1; R5A/ARN-7.
C-47 Illustrated Parts Catalog $15.00.

ALLIED Aircraft Co.

RADIO ENGINES

5536 SATSUMA AVENUE
NORTH HOLLYWOOD, CALIF., U.S.A.
SUnset 3-7477 STanley 7-2151

(Continued from preceding page)
opinion in "The Air Freight Case," authorizing Flying Tiger Line, Slick Airways and U. S. Airlines to operate scheduled interstate cargo service. This case had been "in due process" *since 1945*, and had cost the taxpayer and the airlines millions of dollars. (The docket contains more than 35,000 pages of evidence, briefs and oral arguments over the four-year period!)

At this writing, rebuttal briefs in the "International Air Freight Case," which was opened on July 15, 1947, are just coming before the CAB. Only a handful of international "non-skeds" are still left in business. Seaboard & Western and Transocean Airlines are all that are left out of some 50 in at the start.

Air-cargo forwarders have been subjected to the same treatment by the scheduled airlines and the CAB. Domestic air forwarders were rendered a favorable decision in September 1948, but the airlines again attempted legal "road-blocking" and it wasn't until March 1949 that a Chicago Court of Appeals approved the CAB's authorization. Again, there were only a handful left out of the original 100 that had weathered the four-year delaying action fought by the airlines.

The International Air Freight Forwarder Case was submitted for decision in June 1948, and, according to the latest word from CAA dated December 28, 1949, "it is still under consideration by the Board and we have been unable to get any indication as to when we may expect further developments in this case."

Air Cargo—1949. —During the year just past, Government and carrier statistics have shown that air-cargo traffic has surpassed all but the most optimistic expectations. The CAA reports *(Table I)* show a 100% increase in cargo ton-miles over last year, with a corresponding increase of only 30% in express ton-miles. Interpreting this result, in comparison with domestic figures, we see that domestic cargo revenue increased 49% more than domestic express revenue. Similarly, international cargo revenue increased 70% more than international express in the same period.

Aircraft Design. —One of the most restrictive conditions in the growth of air cargo has been the almost total absence of aircraft designed and built exclusively for air-cargo operation. This was tragically true in expensive wartime air-cargo transports which were passenger planes stripped down for cargo utility. The round fuselage, unsuitable cabin dimensions, loading-door inadequacy and many other drawbacks too often restricted loads.

As far back as 1940, cargo-wise industrialists and surface-traffic specialists told the airlines and the aircraft manufacturers that this was the case. Even the airlines knew it. C. R. Smith, of American Airlines, stated in April 1940 that especially-designed equipment was essential to any all-cargo operation. A few days before Pearl Harbor, the AAF was given minimum specifications for cargo aircraft by the industry. However, in July 1942, after much discussion in the halls of Congress, it was decided that cargo aircraft could be built only at the expense of other war equipment. Thus, air cargo had a five-year stumbling block put in its path, one that it is jsut now managing to climb over.

In November 1946, Lockheed Aircraft Corp. offered a concise presentation of design requirements for modern air-cargo transports. This they have been doing every year since then, at practically every aviation conference and convention. During the recent Air Cargo sessions at the annual meeting of the American Society of Mechanical Engineers in New York, United Air Lines and the Military Air Transport Service both have reiterated this theme and pleaded that design engineers shall take up the torch and come up with a suitable all-cargo aircraft.

An interesting thing about all these pleas is that, ever since 1940, every person that has made one, has been urging consideration of the same design specifications. In other words, everyone — manufacturers, airline executives and the military—is generally agreed on the type of aircraft that is needed. Yet, although it has been more than four years since the end of the war, *there is not one such aircraft in commercial service!*

Douglas, with their DC-6A and *Globemaster II;* Chase, with their *Avitruc;* Fairchild, with their *Packet;* and Northrop, with their *Raider* have provided ingenious interim substitutes. However, all but the DC-6A are primarily military aircraft, with military rather than commercial design considerations incorporated.

The commercial all-cargo aircraft, briefly,

should be designed to operate in the 300-*mph* cruising range with a payload of about 20,000 or more *lbs* over an average range of 2000 *mi.* The floor level should match the average floor level of large pickup and delivery trucks and loading platforms, and the craft should have at least two cargo doors—to permit simultaneous loading and unloading—wide enough to handle bulky and elongated cargo. There has been quite a discussion as to where these doors should be placed. Some experts say nose and tail; others say port and starboard sides of the fuselage; and still others say on the same side of the fuselage.

If the only bone of contention is the location of the cargo doors, as seems to be the case, it is suggested that the cargo carriers, the transport manufacturers and the military should get together *now* and design a utilitarian cargo airplane that would be economically suitable for *commercial* operation and still fit military requirements. If this necessitates Government subsidy, *then let's have it.* The Government should consider it money well spent.

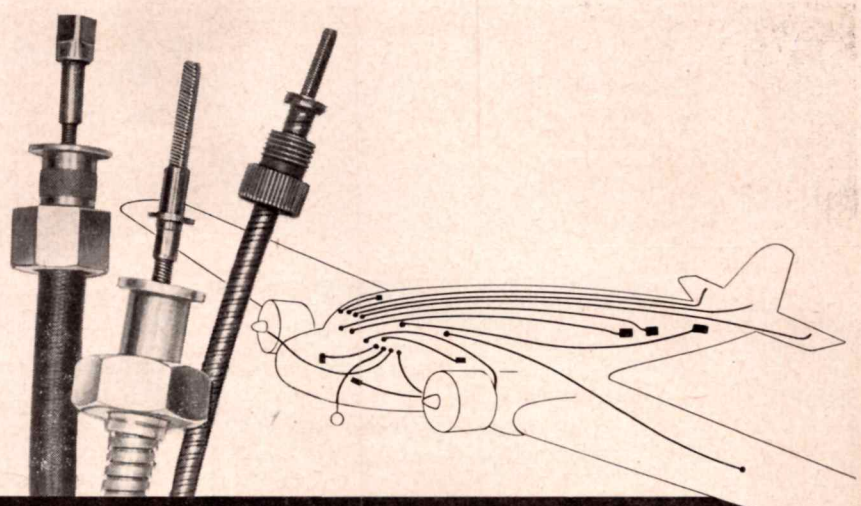
Ground Handling. –It has been proved, beyond the shadow of a doubt, that most of the delays and operational costs in air-cargo operation have been caused by comparatively inefficient ground handling. R. Dixon Speas, of American Airlines, demonstrated this point conclusively during the recent ASME session when he showed that 81% of the intransit time of a New York-Chicago shipment was spent on the ground and 67% of the in-transit time of a New York-Los Angeles shipment was spent in the same place. He proved also that ground-handling costs total from 10 to 50% of total cargo operational costs in corresponding distances of from 2500 to 250 miles.

Many organizations and transportation firms have offered solutions for this problem. Lockheed and Douglas Aircraft have designed new cargo terminals; American Airlines has developed new handling procedures; Eastern Airlines and Douglas have done likewise; MATS showed, on the Berlin Airlift, how assembly-line techniques saved both time and the taxpayers money in the ground handling of one aircraft every 48 seconds; the Air Freight Forwarders Association has been promoting consolidation of cargo shipments and centralized loading, unloading and routing.

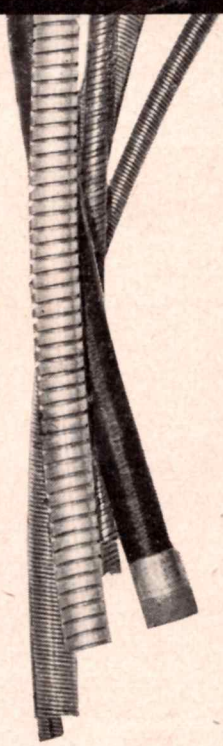
Of all these techniques, it is believed that each has its own role to play in the over-all advance of air cargo as an industry. But, it seems that the establishment and operation of consolidated terminals comprise the one thing that will do the most to solve ground-handling difficulties.

However, the American carriers seem slightly hesitant, to say the least, to give up any of their individuality and pool their resources, on any large scale, with their brother carriers. It will not be until they learn the lesson that the European air carriers did—through cutthroat competition —that air-cargo traffic will get out of this bottleneck.

In any major European city, notably Brussels, London and Paris, all a shipper has to do is call one telephone number to get service on any airline, *including American flag carriers.* Incidentally, these American carriers have, in many instances, jealously



Bring power or control to any point with . . . S.S.WHITE FLEXIBLE SHAFTS



There's no simpler way to drive or control instruments and accessories from remote points, than with S.S.White flexible shafts. No matter where a part is mounted, a shaft can be run right to the spot.

Like electric wiring, S.S.White power drive and remote control shafts are readily installed out of the way. They can be run along contours and around intervening obstacles. And they'll provide smooth, efficient operation over long distances as well as short.

S.S.White flexible shafts come in a wide selection of sizes and characteristics, made to your specific length requirements. Write today for complete details.

S.S.White MAKES IT RIGHT

Send for Bulletin 4501

It contains basic information about flexible shafts and how to select and apply them. Write for your free copy today.

S.S.WHITE INDUSTRIAL DIVISION
THE S. S. WHITE DENTAL MFG. CO. — DEPT. J — 10 EAST 40th ST., NEW YORK 16, N. Y.

FLEXIBLE SHAFTS AND ACCESSORIES
MOLDED PLASTICS PRODUCTS—MOLDED RESISTORS

One of America's AAAA Industrial Enterprises

VELLUMOID
THE STANDARD TREATED FIBRE PACKING
VELBESTOS 170-1
CONFORMS TO AERO SPECIFICATIONS AMS3232E
THE VELLUMOID COMPANY · WORCESTER 6 · MASS.

WASHER DEPENDABILITY
Most important in airplanes. Reduces vibration—protects machine—adds to safety!
Made strictly to your specifications, by specialists. Send specifications for prompt estimate *today*. Ask for catalog.
QUADRIGA *Quality* WASHERS
Also METAL STAMPINGS. Any design, in all metals. Ask for details.
THE QUADRIGA MANUFACTURING CO.
211 W. Grand Ave., Chicago 10, Ill.

FOR ECONOMY—
FOR ACCURACY—
FOR DEPENDABILITY—
Specify WHITEHEAD Stampings
Suppliers to American industry for 46 years.
WRITE FOR YOUR CATALOG!
WHITEHEAD
EST. 1903
WHITEHEAD STAMPING CO.
1665 W. Lafayette Blvd., Detroit 16, Mich.

"protected" their independence by duplicating, with American personnel and equipment, all the facilities that have been available for some time, and which they have been invited continuously to use.

Until the time when consolidated ground service throughout the U. S. and all over the world becomes an operating reality, the air-cargo industry will remain in the throes of adolescence.

Prognosis.—There are some basic principles that, if adhered to, foretell good times (at last) for the air-cargo industry. It has been said that the air-cargo potential has not even been tapped. That is true. But it *will not be tapped* until several things happen:

(1) Until shipper and consignee can be assured of a scheduled cargo service that will serve his needs in regularity, speed, economy and efficiency;

(2) Until all-cargo aircraft are designed, built and operated, that will allow the airlines to offer this type of service;

(3) Until ground-handling and traffic techniques are completely overhauled, permitting rapid and efficient surface transport from shipper to aircraft and from aircraft to consignee;

(4) Until the regular and all-cargo carriers stop their eternal bickering and backbiting and settle down to build a strong air-cargo industry that will do the thing it should do—serve the shipping public well;

(5) Until the Government realizes that the air-cargo industry needs more assistance and less regulation, both financially and legally:

(6) Until the manufacturers and producers of air-transportable material realize that speed at high cost is *not* the object of air cargo, but economical speed that will reduce their total shipping costs, lower their inventories and make their merchandise more saleable to a discriminating public.

Not until these things occur—then and only then—will air cargo grow into its own and become a normal part of our economy to be used and respected by all.

Table I

CAA ESTIMATES—CALENDAR YEAR 1949

Item	*1948*	*1949*	*% Change*
Number of Scheduled Aircraft	1061	1080	+ 2
Revenue Miles Flown (Total)	436,270,200	459,691,000	+ 5
Domestic	338,216,800	352,384,000	+ 4
International	98,053,450	107,307,000	+ 9
Ton Miles Express (Total)	71,497,200	80,233,000	+ 12
Domestic	30,092,850	26,469,000	— 12
International	41,404,350	53,764,000	+ 30
Ton Miles Cargo (Total)	75,472,200	106,095,000	+ 41
Domestic	71,283,750	97,724,000	+ 37
International	4,188,500	8,371,000	+100

JET-POWERED SPORT PLANE

(Continued from page 24)

five small, semi-circular plates projecting from the upper and lower surfaces of each wing. The landing gear is extremely simple, comprising a single cord-sprung wheel of 16.5-*in* diameter embodying a hydraulically-operated brake, located behind a short central skid which contains a much smaller wheel to aid in moving the plane on the ground.

The *Cyclone* has a span of 47 *ft* 8 *in*, a length of 21 *ft* 10 *in*, and a height of 5 *ft* 10 *in*. Its wing area is 140 *sq ft* and its gross weight is 1180 *lbs*, giving it a wing loading of 8.44 *psf*.

The Turbomeca *Pimene* turbojet used on the *Cyclone* is the simplest form of gas turbine imaginable. It consists of a single-stage compressor of the centrifugal type, an annular combustion chamber and flame tube, and a single-stage turbine. The compressor impeller and the turbine rotor disc are mounted on opposite ends of a hollow driveshaft carried in two ball bearings, the rear one of which is air cooled. The exhaust nozzle is of the fixed-area type. Aluminum alloy is used for the compressor casing and impeller. The combustion chamber is of mild steel, with a stainless-steel inner flame tube. *Nimonic 80* alloy is employed for the turbine rotor disc and its solid blades.

The fuel system is quite different from the high-pressure systems embodying complicated fuel pumps, multiple fuel lines and injectors now in common use on aircraft gas turbines.

On the *Pimene* there is employed a low-pressure system in which the fuel is pumped at a pressure of 60 *psi* into the front end of the hollow compressor-turbine driveshaft which serves as a fuel line to a small disc mounted on the shaft and projecting into the front end of the combustion chamber. When the engine is running, the fuel enters a number of passages in this disc and is sprayed out by centrifugal force into the primary air flow through small orifices in the rim of the disc.

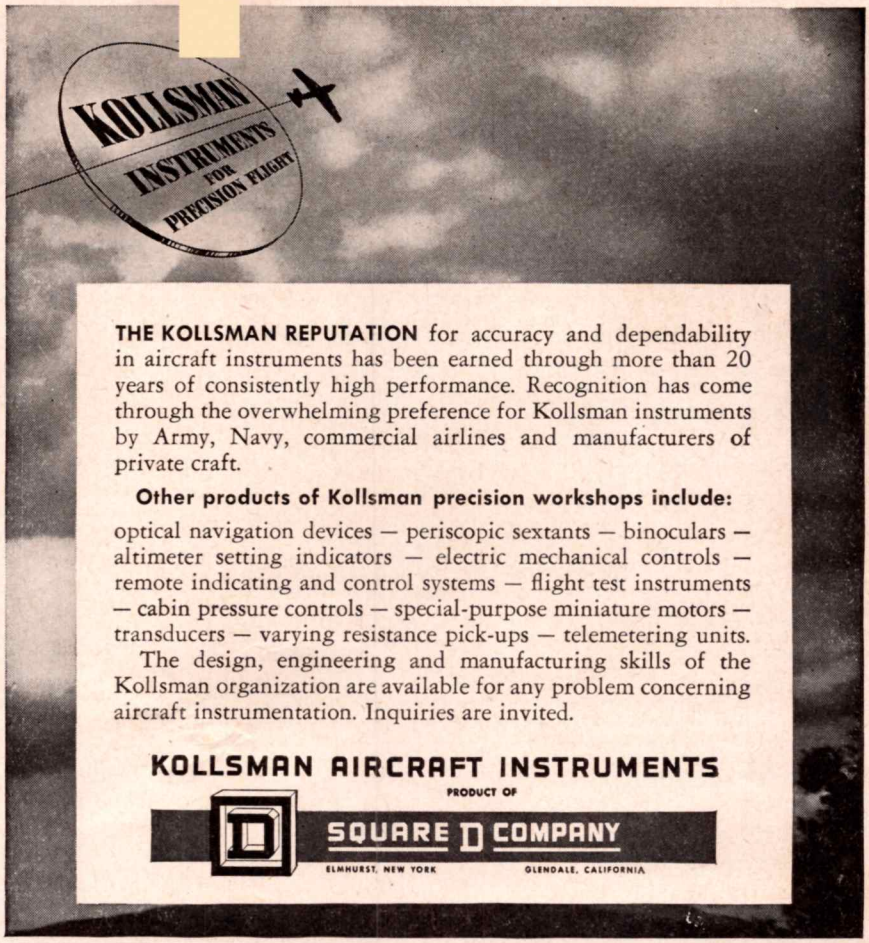
Control of the engine is effected by means of a single-lever throttle-control unit embodying an automatic speed and pressure (altitude) regulator of Turbomeca design, with a bypass for slow-running. When the plane is used as a glider, the engine can be throttled down to idling, or shut off altogether once the desired altitude has been attained. Lubrication is provided by a gear-type pump operating at 50 *psi* on the dry-sump principle.

Starting the engine is simple. A 2-*hp* portable electric motor is pushed against the nose of the compressor so that a dog-clutch on the starter shaft engages with the front end of the compressor-turbine driveshaft. The starter motor is connected by a flexible cable with a 24-volt battery cart. When the current is switched on, the motor spins the rotating element of the turbojet up to 5000 *rpm*, at which time the fuel and ignition are turned on. When the engine fires, it builds up speed and disengages the clutch. Future models may have a built-in starter motor, or a miniature combustion starter might be used.

The *Pimene* is extremely small, considering the power it produces. It is only 16 *in* in diameter, with a frontal area of 1.4 *sq ft*. Its length is 43 *in*. Without starter, it weighs 120 *lbs*. It is rated at 220-*lbs* thrust at 35,000 *rpm* at takeoff, and 175 *lbs* at 33,000 *rpm* at cruising speed, both static at sea level. This makes its specific weight 0.59 *lb/hp, which compares* with an average specific weight of 1.77 *lb/hp* for reciprocating engines of similar power output. Its fuel consumption, using kerosene with the addition of 2% of lubricating oil, is 1.06 *lb/lb*-thrust/*hr*, which is about the same as that of the larger turbojets in use today. The lubricating oil consumption is negligible.

The *Pimene* passed the 150-*hr* type test prescribed by the French Air Ministry for civil-aircraft powerplants. *Table 1* compares the *Pimene* turbojet with reciprocating engines of comparable power.

Despite the relatively high fuel consumption of the *Pimene*, which cruises at 80% maximum-power output compared with an average of 70% maxi-



THE KOLLSMAN REPUTATION for accuracy and dependability in aircraft instruments has been earned through more than 20 years of consistently high performance. Recognition has come through the overwhelming preference for Kollsman instruments by Army, Navy, commercial airlines and manufacturers of private craft.

Other products of Kollsman precision workshops include:

optical navigation devices — periscopic sextants — binoculars — altimeter setting indicators — electric mechanical controls — remote indicating and control systems — flight test instruments — cabin pressure controls — special-purpose miniature motors — transducers — varying resistance pick-ups — telemetering units.

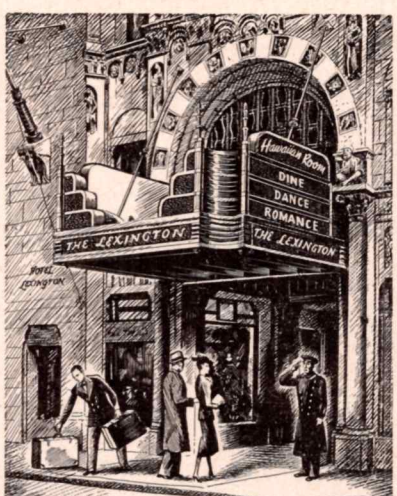
The design, engineering and manufacturing skills of the Kollsman organization are available for any problem concerning aircraft instrumentation. Inquiries are invited.

KOLLSMAN AIRCRAFT INSTRUMENTS

PRODUCT OF

SQUARE D COMPANY

ELMHURST, NEW YORK GLENDALE, CALIFORNIA



FOR YEARS, THE ACCEPTED
NEW YORK
"HEADQUARTERS"
OF AVIATION EXECUTIVES

Hotel Lexington

LEXINGTON AVENUE AT 48th ST., N. Y. C. 17

HOME OF THE *Hawaiian Room*

CHARLES E. ROCHESTER, *President*
George W. Miller, *Resident Manager*

CPI

SUPER HIGH TEMPERATURE THERMAL SWITCH

0 TO 2000° F NORMALLY OPEN

for JET ENGINES
GAS TURBINES
ROCKET MOTORS
AFTER BURNER CONTROL

Outstanding for its ability to maintain temperature calibration for 100 hours at 1500° F. within ± 10° F. Flange or screw type mounting optional. Grounds on temperature rise. Probe 3 inches long; weight 5½ ounces. Write for blueprints and specifications. Discussion of your high temperature control problems invited.

CONTROL PRODUCTS · INC
306 SUSSEX STREET
HARRISON, NEW JERSEY

DESIGNERS AND MANUFACTURERS OF THERMAL DEVICES

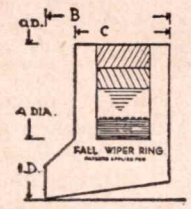
FALL WIPER RINGS*

(Spring-Loaded, with "Squeeze-Grip Action")

Keep the Piston Tube Clean!

For landing gear and hydraulic equipment. Replaces regular AN6231 Wiper Rings. Mf'd under Spec. AN6231A with respect to body material, dimensions & performance in accord with Spec. MIL-S-5049, superseding Spec. AN-S-60. Inquiries invited. (*Patented)

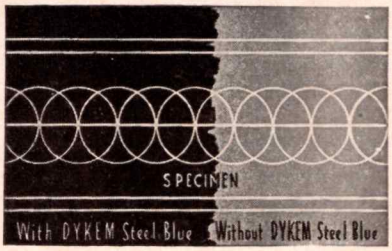
ACE PRODUCTS CO., TOLEDO 1, OHIO, U.S.A.



DYKEM STEEL BLUE

STOPS LOSSES

making dies & templates



Simply brush on right at the bench; ready for the layout in a few minutes. The dark blue background makes the scribed layout lines show up in sharp relief, and at the same time prevents metal glare. Increases efficiency and accuracy.

Write for full information

THE DYKEM COMPANY, 2303B North 11th St., St. Louis 6, Mo.
In Canada: 2406 Dundas St. West, Toronto, Ont.

AERO DIGEST REPRINTS

★ ★

ROY LIMING'S AIRFOIL DEVELOPMENT AND STRUCTURE WITHIN THE CAMBERED SURFACE

Written by the Engineering Lofting Mathematics head of North American Aviation, Inc.

All 10 installments, just as they recently appeared in successive numbers of AERO DIGEST, now published all together in a limited edition and sold while the supply lasts at $1 each postpaid.

Send your request with only One Dollar to

AERONAUTICAL DIGEST
Reprint Dept.
515 MADISON AVENUE, NEW YORK 22, N. Y.

mum power output for the reciprocating engines, the much lower weight of the turbojet gives it an advantage over the reciprocating engines of higher installed weight, and lower fuel consumption when flights of less than 2.5 hours' duration are undertaken.

One can visualize many uses for the Turbomeca *Pimene* in Fouga *Cyclone*-type gliders and lightplanes of various kinds. A twin-engine installation would be a very attractive proposition. Flying with low-powered turbojets is no longer a dream—it's a reality which many airmen will be taking advantage of in the near future.

CONVERTIBLE-AIRCRAFT CONGRESS

(Continued from page 21)

that of our present transport planes together with the vertical takeoff-and-landing characteristics of our helicopters."

Some Actual Wind-Tunnel Tests of a Convertible Aircraft.—Mark Twain said that everybody talked about the weather, and nobody did anything about it. The same almost might be said about the convertaplane, but not quite. For example, Charles H. Zimmerman of the NACA, designer of the *Flying Pancakes*, has built and tested wind-tunnel models of convertible aircraft *(Performance and Stability of a Convertible Aircraft)*. He has concentrated attention on that class of convertible in which the rotor axis swings through 90° in going from hovering flight to forward flight, and in which the entire aircraft is rotated. His design *(fig. 2)* comprises an airfoil of very low-aspect ratio, serving as the fuselage; two large counter-rotating, tractor propellers or rotors, vertical and horizontal tail surfaces and a landing gear capable of holding the body at very high angles on the ground.

Mr. Zimmerman discussed his design in three states:

(1) Hovering, Including Takeoff and Landing
The landing gear must be capable of supporting the aircraft with axis vertical, and of retraction. The trailing edge of the airfoil is really a large flap that serves to trim the convertible near the ground or in flight, and permits reduction in landing-gear length. Models flown as helicopters were nearly stable longitudinally. Longitudinal control in hovering was achieved by the simultaneous deflection of the two horizontal fins, called ailavators; control about the vertical axis by differential deflection of ailavators; and control in roll by deflection of the rudders.

(2) Transition from Hovering to Airplane
To achieve transition, there should be no sudden changes in power or control setting, craft must remain controllable, and controls should give motion in the same sense about the same body axes at all speeds. Zimmerman's model flight, tunnel tests and calculations show that these requirements could be met. But the airfoil must not stall; and low-aspect ratio and the intense slipstream of moderate-size rotors will prevent stalling. Although longitudinal control can be achieved successfuly in the transition stage, a certain amount of longitudinal instability must be accepted.

(3) Flight as an Airplane
An aircraft of this type is sufficiently understood and has been covered in a number of reports. The prime question that interests the convertaplane designer is: Is it feasible to use the rotor of a convertible for both sustentation at low speeds and propulsion at high speeds?

And here are the answers that will encourage such designers:

a. The same roto *can* be used for both conditions
b. It should be primarily a propeller of rather low pitch and twist
c. Extreme care must be used in selecting the propeller, with due attention both at static thrust and propulsive efficiency at high $V/_{nD}$
d. The diameter should be as large as possible without sacrificing transition and high-speed characteristics
e. Disk loading of the rotor probably will be too high for safe autorotation; therefore a twin-engine powerplant is necessary.
f. It is possible to improve efficiency in forward flight by reducing *rpm* and increasing the $V/_{nD}$, and two-speed gearing is desirable for speeds about 250 *mph*.

A New Approach To Convertibility.

Thus far, we have reported the views of the "evolutionists"—imaginative but cautious engineers. Now let's see what the "revolutionists" had to say. The first of these was Anton Flettner, inventor of the *Flettner Tab*, of the surface vessel driven by rotating cylinders, and of the intermeshing side-by-side helicopter.

We cannot do full justice to Mr. Flettner's conceptions and state only his main principles:

(1) The lift rotor should be situated on the airplane in such a way as to change the appearance of the normal airplane as little as possible.

(2) The size of the fixed wing should remain unchanged

(3) The fixed wing should have enough area for the conversion to take place at a relatively low space

(4) The rotor should, in forward flight, exert as little drag as possible, and means should be provided to bring them into the minimum drag position. Since they are additional elements only and perform additional functions, they should be of reasonable size. This results in high-loaded and high-powered rotors

(5) The lift rotors create a strong downwash which should not strike the fixed wings

(6) Rotors should be placed where their downwash does not interfere with the conventional propellers.

These principles clarify *fig. 3.* Four rotors are necessary for a satisfactory solution; and to reduce downwash interference effects: the booms are streamlined in a vertical plane, the projection of the rotors is clear of the fixed wing, and the forward rotors are located higher, and the aft rotors lower, than the fixed wing.

Fig. 3 shows also, in dotted lines, an impeller or wind motor geared to the shafting which connects all the rotors of the plane. The wind motor is to set the lift rotors into motion and to maintain their autorotation in case of engine failure. A variety of powerplant combinations have been discussed: gas turbines, compressors, alternate drives to propellers and rotors.

Lloyd H. Leonard amplified, with careful aerodynamic calculations, his ideas on tilting-fuselage convertiplanes, "defined as that class of convertible aircraft wherein the fuselage axis tilts with the rotor system during conversion from vertical to horizontal flight." In *fig. 4* there is shown a conception of Leonard's which we believe he has not disclosed thus far, a mid-fuselage rotor design. He describes it as follows:

"Although the high position of the pilot and passenger compartment, when the machine is on the ground, is somewhat objectionable from the standpoint of ease of entry and exit, the pilot has excellent visibility for all conditions of flight and is not subjected to undue hazards in the event of a hard landing. The rotors are so located that the centroid of their projected side area is a short distance aft the center gravity, thereby permitting the use of the lifting capacity of the rotors in horizontal flight to eliminate wings.

"The forward position of the fins trims the machine in horizontal flight and aids stability during vertical flight. Moreover, the reduction in the projected side area of the blades during vertical flight, due to the lower pitch, shifts the aerodynamic center upward—possibly to a point slightly above the center of gravity—thereby further aiding helicopter stability."

The Father of the Convertible. —It was most fitting that Gerard P. Herrick, the father of the "convertible" idea, should receive an award for his distinguished work at the "Old Timers' Luncheon." Readers will remember that Herrick, quite a number of years ago, succeeded in converting, in flight, the fixed upper wing of a biplane into an autorotating rotor and landing his convertaplane with the ease of an autogiro. Now, he is carrying his ideas further to their logical conclusion.

The latest model upon which he is working, the HC-6D, is a boom-tail, pusher sesqui-plane. The upper fixed wing is releasable for auto-rotation as a gyro and for driven rotation as a helicopter. Here is a brief specification as given in Mr. Herrick's paper:

Gross weight—3450 *lbs;* weight empty—2489 *lbs;* speed range 0 to 220 *mph;* main reciprocating traction engine of 300 *hp;* rotor tip-jet engines develop 200 *lbs* thrust; cruising range— 400 to 800 miles, depending on pay load. Flight controls in all three types of flight (airplane, autogiro and helicopter) are by identical conventional movements of the dual wheel-stick, except that there is a separate vertical-flight lever. Conversion from one regime of flight to another is to be achieved by simple movement of a conversion lever.

A Resolution. —If the Congress did not solve all the problems of Convertible Aircraft, it laid down new directions, added to the enthusiasm of its proponents, made new converts to the cause and sent the following unanimous resolution to the President. The House of Congress, Defense Secretary Johnson and others:

Whereas—

Fixed-wing airplanes can fly fast, far and carry heavy loads, and the helicopter can take off and land in any kind of weather and in restricted areas, but lacks high speed performance, and

Whereas—

An efficient combination of the flying qualities of the two types would be of great use to the Armed Services and to the Commercial Aviation of the United States, and to safety and usefulness of flying in general, the First Convertible Aircraft Congress feels it to be its duty and

Resolves—

To call attention of the Secretary of Defense and the Secretaries of the Armed Forces, the Research and Development Board, the NACA, the CAB and the CAA to the need of the immediate development of this type, and recommends to the President, the Budget Bureau and Congress that at least $10,000,000 of the national research-development funds be allocated to private experimenters, universities and industrial organizations who can devote their main energies and the greater part of their time to perfecting the most promising configurations of this type of aircraft.

Classified ADS

Forms for Classified Advertising close one month in advance; payable in advance at 10 cents per word; $2.50 minimum

AVIATION BOOKS

PRIVATE and COMMERCIAL PILOTS. An outstanding text by Charles A. Zweng "just published." New examinations which you will not find elsewhere, prepare you. Just order "Aeronautical Training" original "Quiz System" for Private and Commercial Pilots—two books in one, only $3.00 postpaid or C.O.D. Pan American Navigation Service, Dept. AD-2, 12021 Ventura Blvd., N. Hollywood, Calif.

AVIATION BOOKS

AERONAUTICAL SUPPLIES NOW READY: New Practical Manual of E-6B Computer $2.50; Weems Navigation Plotter $2.00; E-6B Computer in Leather Case $10.00; American Airlines Computer with Leather case $5.00; Meteorology for Airmen, (Zweng) $3.00; Ground Instructor Rating (Zweng) with examinations $3.00; Flight Instructor Rating (Zweng) with both oral and written examinations $3.00; New Private Pilot Booklet with examinations included only $1.00; Parachute Technician, prepares you for your rating $3.00; Airport Operation and Management by Zweng; DeLuxe $4.50; Airline Pilot Transport rating with examinations only $4.00; Instrument Flying (Howard Stark Edition) with new examinations; red DeLuxe Leather by Weems and Zweng $4.50; Flight Engineer (Zweng) $4.00; Flight Navigator (Zweng) $3.00; Aircraft Dispatcher $4.00; New Airline Pilot Log Books $2.00 each; Flight Engineer Log Book $2.00; New Aeronautical Navigation by Charles A. Zweng (examinations included) only $3.00; Link Instructor Manual (Zweng) examinations included $4.00; Zweng Aviation Dictionary $6.00; (Free catalog with order). We are government agents for Aeronautical Charts. CAA Bulletins. Pan American Navigation Service, Dept. AD-2, 12021 Ventura Blvd., N. Hollywood, California.

AVIATION BOOKS

AIRCRAFT & ENGINE MECHANICS MANUAL (by Zweng) prepares you for your rating. Latest "Multiple Choice Examinations" with material not found elsewhere—including latest CAR, weight and balance and procedure governing repairs, only $3.00 postpaid or C.O.D. Pan American Navigation Service, 12021-24 Ventura Blvd., N. Hollywood, Calif.

GROUND INSTRUCTOR RATING—Covers Fundamentals of Instruction, Navigation, Meteorology, Powerplants, Aircraft and CAR. Original "Quiz System" by Zweng (5 subjects in one text), only $3.00 postpaid or C.O.D. Pan American Navigation Service, Dept. AD-2, 12021 Ventura Blvd., N. Hollywood, Calif.

ELECTRONIC NAVIGATION. We announce this new first edition by Col. Leonard M. Orman. This book covers a new and important field. Red & Gold Deluxe Edition $4.50. Pan American Navigation Service, Dept. AD-2, 12021 Ventura Blvd., N. Hollywood, Calif.

CLASSIFIED ADS

FOR SALE

PILOT'S Oxygen Kit, 6" x 24" liteweight tank, demand regulator, gauge mask, AAF D-2 type. New surplus. Cost app. $100.00, now only $7.95. Filled with oxygen (450 lb.), $2.00 extra. 6" extension hoses for mask, $2.00. Express shipment on filled tanks. Aero Parts Supply, Municipal Airport, Houston, Texas, Dept. AD.

NAVION Owners. Install the original landing gear fairing to be approved by CAA for the Navion $85.00. H. E. Tennes, 801 Burlington Ave., Downers Grove, Ill.

FOR SALE

POCKET Adding Machine. Save yourself time and money. With Leatherette case, $2.98. The Beber Co., P. O. Box 42, Cincinnati 29, Ohio.

For Sale—one Heiland A401 portable 6-channel oscillograph with suitable mixing boxes for simultaneous recording of strain gages, accelerometers and pressure gages; charging equipment, cables and other accessories. Write Aero Digest, Box 4193.

FOR SALE

SAFETY Pilot Belts, Type B-11, new individually boxed. Government surplus. $6.00 dozen. FOB Kansas City, Missouri. Sample $1.00 each postpaid. Acme Outlet, 3904 Prospect, Kansas City, Mo.

HELP WANTED

FOREIGN Employment. Construction men, building trades mechanics, helpers, office men. Good workers needed for oil projects, mining, pipe lines, dams, power plants, roadways, shipping, etc. Transportation and quarters furnished; high wages. Listings of firms actively working and hiring on projects in South America, Arabia, Asia, Africa, Alaska, Central America, etc. Send $1.00 for foreign construction compendium and application forms. Foreign Service Bureau, Dept. AD-1 (Employment), P. O. Box 295, Metuchen, N. J.

SAVE MONEY $$$—Your LEATHER JACKET cleaned—dyed—relined—repaired—parts replaced. Send postal for FREE circular. Dept. 41, BERLEW MFG. CO., Freeport, N. Y.

BUYERS' Directory

Rates: $9 per column inch, single insertion; $8.10 per column inch, six insertions; $7.65 twelve insertions per year

AERONAUTICAL RADIO MFG. CO. MINEOLA, N.Y.

SALES—INSTALLATIONS—SERVICE

Distributors for

RCA Weston Ranger Gould

Radio — Instruments — Radio — Batteries

• ***Aeronaut Products:*** Antenna Reels, Drag Socks, Fair Leads, Wire, Tension Springs, Insulators, Noise filters, Microphones, Headphones, Relays, VHF Parts, Aeronautical Radio Hardware and Accessories.

Rising Sun SCHOOL OF AERONAUTICS

ESTABLISHED 1930

"Built Upon the Success of Its Graduates"

GOVT. C.A.A. & VETERANS APPROVED

ENROLL NOW FOR NEXT CLASS

Write for Illustrated Catalog.

2206-16 E. HUNTINGDON ST., PHILA., PA.

FOR SALE

West Coast's largest stock of Douglas, Constellation and Curtiss-Wright airframe parts; we will meet or better your present buying price. Preferential discounts to end users. AN fittings, nuts, bolts, batteries, gas caps, pulleys, bearings, electrical parts, spark plugs, switches, valves.

Plus a $40,000,000 inventory of new and surplus parts.

Complete catalog forwarded upon request.

COLLINS ENGINEERING COMPANY

9054 Washington Blvd. Culver City, Calif.

AERO PUBLISHERS INC

AVIATION BOOKS for 1949

Write for NEW FREE catalogue

AERO PUBLISHERS, INC.

2162-(A) Sunset Blvd., Los Angeles 26, Calif.

AMC SUPPLY CO. BARGAINS

U. S. Koylon Foam Rubber

Flat or Cored Stock for immediate delivery. Write for complete information.

C-2 Altitude Computers

Used for all types of altitude correction. Large, easy to read print, the most accurate available.

50c each

Write for complete, illustrated catalogue of Aircraft and Rubber Products due out soon.

AMC Supply Company

P. O. Box 1440-E Fort Worth, Texas

AERO TRADES

INC.

ROOSEVELT FIELD, L. I.

EXPERIMENTAL WORK

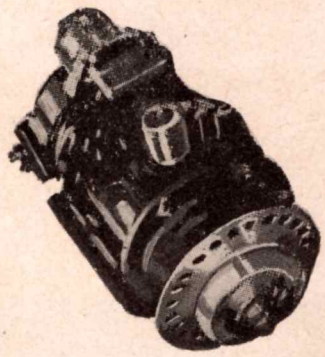
MODIFICATIONS ENGINEERING

Specialists in Manufacturers of Wood & Metal Airplane Parts

Upholstering

Government Approved Station 115

STARTERS



TYPE G-6A, 4E or F

ECLIPSE #915

APPROVED FOR ALL DC-3 & C47 AIRCRAFT

NEW - $17.50

TEST STARTERS

ONLY SLIGHTLY USED

LIKE NEW $10.00

SP.-"AIR"-ES, INC.

2315 W. Ogden Avenue

Chicago 8, Illinois

AAF PICTORIALS

Over 250 pictures.

Bombers—fighters—flak—action—points of interest. Official War Dept. history. $3 each postpaid. Specify which air force you want. C.O.D.s O.K.

AAF PUBLICATION CO.

1631-55 W. 3rd St., Los Angeles 36, California

PESTER'S

PROPELLER SERVICE, INC.

MINEOLA, L. I., N. Y.

EST. 1930

APPROVED REPAIR STATION #182

BUYERS' Directory

Rate: $9 per column inch, single insertion; $8.10 per column inch, six insertions; $7.65 twelve insertions per year

AIRCRAFT

BEECHCRAFT

N9405H

D17S

P&W R985 — AN6B

BABBCO— *Executive* —SHIP

HAND RUBBED FINISH
RED WITH BLUE TRIM

Two-Way Radio and Direction Finder

Tel. Mitchell 3-6840

The Babb Company, Inc.
Newark Airport, Newark, N. J.

DC-4

(Type C-54B-DC)

ACCOMMODATES 44 PASSENGERS

Has recent 1000-hour inspection. To be delivered with certificate. P&W R-2000-7 Engines
Price on Application

THE BABB COMPANY. INC.
444 Madison Avenue,
New York, 22, N. Y.
TEL. PL 8-2361

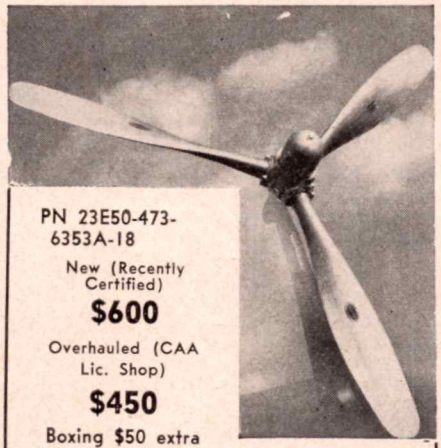
GOVERNORS

NEW, TESTED AND CERTIFIED

For P51 Operators	**For Wright** R1820 or P&W R1830 users
PN4G10-P21G 4G10-G21G (Interchangeable with 4G10-G21D) **$100.00 each**	4G8G30M/ 4G8P30M **$135.00 each**

MALLARD OPERATORS
4K11-U4T...$125

C-47 TOOTHPICK PROP



PN 23E50-473-6353A-18

New (Recently Certified)
$600

Overhauled (CAA Lic. Shop)
$450

Boxing $50 extra

PBY Props PN23E50-473-6353A-12
New **$650** ea. (Recently Certified)
Overhauled **$450** ea. (CAA lic. shop)

444 Madison Avenue
New York 22, N. Y.

SHOP EQUIPMENT

VERI-DRIVES
15-30-300
GENERATOR
TEST UNITS
Model OTDB
OVERHAULED
$1250 — FOB

The Babb Company, Inc.
Tidewater Terminal
NEWARK, N. J.

PRATT & WHITNEY

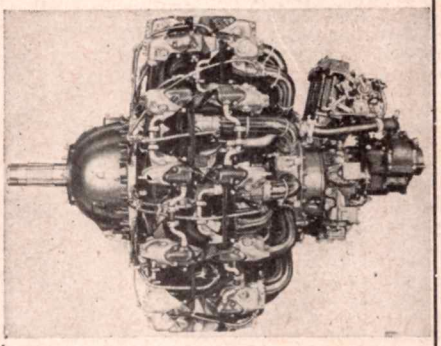
PARTS FOR R1830-92

Rear Crankcase—Machining & Stud Ass'y (New)—PN 86497 **$175**...ea.

Harness, Ignition, New PN58242 ..... **$90**...net

THE BABB COMPANY
444 Madison Avenue,
New York 22, N. Y.

FOR SALE



PRATT & WHITNEY ENGINES

R1830-92

MAJOR OVERHAULED to meet AIR CARRIER requirements by approved PRATT & WHITNEY Agency; low time first run, known history; each $2450.

R1830-43-65

MAJOR OVERHAUL (military) first run (average total time 300:00 hours) with zero time since reinspection and block test by recognized agency. C.A.A. Form 337, each $1500.00.

R1340-AN1

NEW (unused) P & W Engines, each $3750.00.

R985-AN-1

MAJOR OVERHAULED by P. & W. approved agency. $1650.

THE BABB COMPANY. INC.
1007 Airway — Glendale, Calif.
TEL. CHAPMAN 5-3191

The following messages are so important that the senders PAY US to print them. It will PAY YOU to read them.

A

A.C. Spark Plug Division 29
Agency—D. P. Brother & Company
Ace Products Company 106
Agency—Bradford & Company
Aerial Products Inc. 83
Agency—James J. McMahon Inc.
Aero Digest Publishing Corp. .....85 & 106
Aerotec Corporation, The 91
Agency—The Harry P. Bridge Co.
Airborne Accessories Corp. 82
Agency—Weber-Thomson Associates
Aircraft Engine & Parts Corp. 3
Agency—Picard Advertising Co.
Aircraft Radio Corporation 80
Agency—Burke Dowling Adams Inc.
AiResearch Manufacturing Corp. 71
Agency—J. Walter Thompson Co.
Albertson & Co., Inc. 4
Agency—E. W. Sann & Associates
Allegheny Ludlum Steel Corp. 67
Agency—Walker & Downing
Allied Aircraft Co. 102
Aluminum Industries, Inc. 32
Agency—The Keeler & Stites Company
American Chain & Cable Co. 25
Agency—Reincke Meyer & Finn
American Electrical Heater Co. 94
Agency—Dudgeon Taylor Bruske Inc.
American Phenolic Corp. 81
Agency—Burton Browne
American Steel & Wire Company 75
Agency—Batten, Barton, Durstine & Osborn
Austenal Laboratories, Inc. 27
Agency—Frank C. Nahser Inc.

B

Babb Company, Inc., The 63
Bendix Aviation Corp., (Radio Division).....8 & 9
Agency—MacManus, John & Adams Inc.
Bendix Aviation Corp.—(Eclipse Pioneer Div.) 31
Agency—MacManus, John & Adams Inc.
Bendix Aviation Corp.—
(Skinner Purifiers Div.) 100
Agency—MacManus, John & Adams Inc.
Bendix Aviation Corp.—(Pacific Division) ... 76
Agency—The Shaw Company
B. H. Aircraft Co., Inc. 92
Agency—Harold Marshall
Boeing Airplane Company 111
Agency—N. W. Ayer & Son Inc.

C

Cannon Electric Development Co. 98
Agency—Dana Jones Company
Chase Aircraft Company, Inc. 95
Columbia Steel Company 75
Agency—Batten, Barton, Durstine & Osborn
Control Products Inc. 105
Agency—George Homer Martin Associates

D

Dill Manufacturing Co., The 99
Agency—McDaniel-Fisher & Spelman Co.
Douglas Aircraft Company, Inc. 51
Agency—J. Walter Thompson Co.
Dykem Company, The 106
Agency—Shaffer-Brennan-Margulis Adv. Co.

E

Esso Standard Oil Company 65
Agency—McCann-Erickson Inc.

F

Fairchild Engine & Airplane Corp. 15
Agency—J. M. Hickerson Inc.
Foote Bros. Gear & Machine Corp. 55
Agency—The Buchen Company
Frontier Bronze Corp. 97
Agency—Melville F. Hall Adv. Agency

G

Goodyear Tire & Rubber Co. 2
Agency—Kudner Agency Inc.
Great Lakes Airmotive Inc. 5
Agency—Advisors Inc.

H

Hi-Shear Rivet Tool Co., The 90
Agency—John T. Hales Co.
Holley Carburetor Company .....2nd Cover
Agency—Holden-Clifford-Flint, Inc.
Hotel Lexington 105
Agency—Elmo Ecker

J

Jack & Heintz Precision Industries Inc. 79
Agency—Fuller & Smith & Ross Inc.
Joy Manufacturing Co. 7
Agency—Walker & Downing

K

Kaiser Aluminum & Chemical Corp. 6
Agency—Young & Rubicam
Keller Tool Company 112
Agency—The Fensholt Company
Kollsman Instrument
Division of The Square "D" Co. 105
Agency—Erwin, Wasey & Company

L

Lavelle Aircraft Corp. 78
Agency—Broomfield-Podmore
Leach Relay Company 93
Agency—The McCarty Company
Lord Manufacturing Company 84
Agency—W. S. Hill Company

M

Marman Products Co., Inc. 89
Agency—West-Marquis Inc.

P

Pacific Airmotive Corp. 94
Agency—Walter McCreery Inc.
Pesco Products 69
Agency—Fuller & Smith & Ross Inc.
Phillips Petroleum Company 16
Agency—Lambert & Feasley Inc.
Piasecki Helicopter Corp. 83
Agency—B. K. Davis and Bro.

Q

Quadriga Mfg. Co. 104
Agency—Symonds, MacKenzie & Co.

R

Reeves Brothers Inc. 10
Agency—Goold and Tierney Inc.
Republic Aviation Corp. 57
Agency—The Albert Woodley Co.
Revista Aerea Inc. 12
Rohr Aircraft Corp. 61
Agency—Barnes Chase Company

S

Society of the Plastics Industry 80
Agency—Lamport-Fox-Prell & Dolk Inc.
Sperry Gyroscope Company .....3rd Cover
Agency—Chas. Dallas Reach Co.

T

Tennessee Coal, Iron & Railroad Company .. 75
Agency—Batten, Barton, Durstine & Osborn
Texas Company, The .....4th Cover
Agency—Erwin Wasey & Company
Timken Roller Bearing Company 73
Agency—Batten, Barton, Durstine & Osborn
Torrington Company, The 59
Agency—Hazard Advertising Co.

U

United Aircraft Corporation .....Front Cover
Agency—Platt-Forbes Inc.
U.S. Steel Corporation of Delaware 75
Agency—Batten, Barton, Durstine & Osborn
U.S. Steel Export Company 75
Agency—Batten, Barton, Durstine & Osborn

V

Vellumoid Company 104
Agency—Smith Associates
Vickers Inc. 11
Agency—Witte & Burden

W

Western Gear Works 101
Agency—West-Marquis Inc.
White Dental Mfg. Co., S. S. 103
Agency—Peterson & Kempner Inc.
Whitehead Stamping Co. 104
Agency—Holden-Clifford-Flint Inc.
Whittaker Co., Ltd., William R. 13
Agency—The McCarty Company
Wittek Mfg. Company 90
Agency—Advertising Corporation
Wyman Gordon Company 14
Agency—John W. Odlin Company Inc.

Z

Zenith Plastics Company 1
Agency—Francis D. Gonda

BUYERS' DIRECTORY

A.A.F. Publications 108
Agency—Lindeke Adv. Agency
Aeronautical Radio Mfg. Co. 108
Aero Publishers Inc. 108
Aero Trades Co. 108
AMC Supply Company 108
Agency—Parker Willson
Babb Company, The 109
Collins Engineering Co. 108
Pester's Propeller Service 108
Rising Sun School of Aeronautics 108
Agency—Joseph Lowenthal
SP-"AIR"-ES, Inc. 108

Classified Advertisements appear on pages 107 & 108

Global Transport - the Stratocruiser!

Here are the insignia of the five major airlines which have chosen Boeing Stratocruisers to lead their global fleets.

This airplane, the twin-deck Boeing Stratocruiser, has now taken its proud place as queen of the fleets of five great airlines. Already Stratocruisers have flown thousands of hours across oceans and continents, covering the main flight routes of a large part of the world.

Stratocruiser service is now available on Pan American World Airways between San Francisco-Los Angeles-Hawaii and the Orient, Seattle-Portland and Hawaii, New York-London, and New York-Bermuda. On Northwest Airlines, Stratocruisers fly transcontinentally between New York and Seattle, Japan and the Philippines via Twin Cities or Seattle, and Seattle-Honolulu. On American Overseas Airlines, between New York, London and the Continent.

Both United Air Lines and British Overseas Airways will also start Stratocruiser service shortly; United between San Francisco and Hawaii; British Overseas between New York and London.

You'll approve every exciting feature of these big, 340-mile-an-hour luxury liners. Two spacious decks to roam about . . . separate large dressing rooms for men and women . . . oven-hot meals served on individual tables . . . the most advanced air and altitude conditioning system in commercial aviation . . . quiet, restful flight on soft, deep-reclining seats.

Next time—go Stratocruiser and enjoy an entirely new experience in fast, comfortable, dependable air travel.

Boeing is building fleets of Stratocruisers for these forward-looking airlines:

UNITED AIR LINES • BRITISH OVERSEAS AIRWAYS CORPORATION

PAN AMERICAN WORLD AIRWAYS • NORTHWEST AIRLINES • AMERICAN OVERSEAS AIRLINES

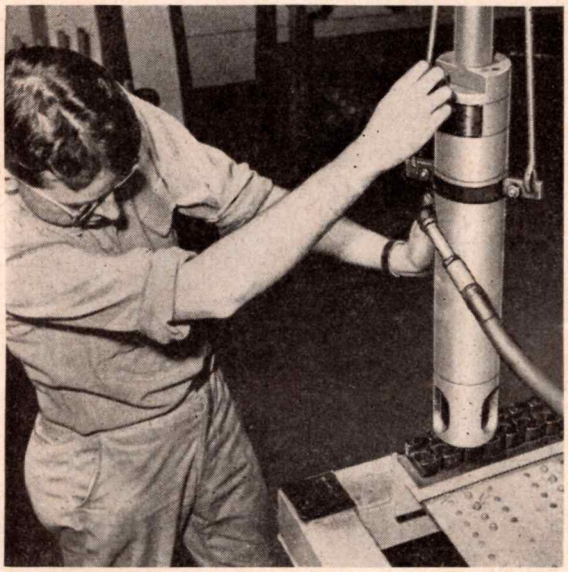
For the Air Force, the B-50 Superfortress, B-47 Stratojet and C-97 Stratofreighter

BOEING

STRATOCRUISER

Keller Airfeedrill

sets new records in speed and accuracy for production drilling



Drilling barrel nut holes, center wing section

Keller Airfeedrill comes to the job instead of the job coming to the drill. Drilling fixture is prepared in advance, with a lock-liner bushing for each hole to be drilled. This fixture is registered on the wing section and secured with C clamps. The Airfeedrill may be lifted from bushing to bushing, or supported by a tool balancer so that when released it will rise above work level and be readily lowered to next drilling operation.

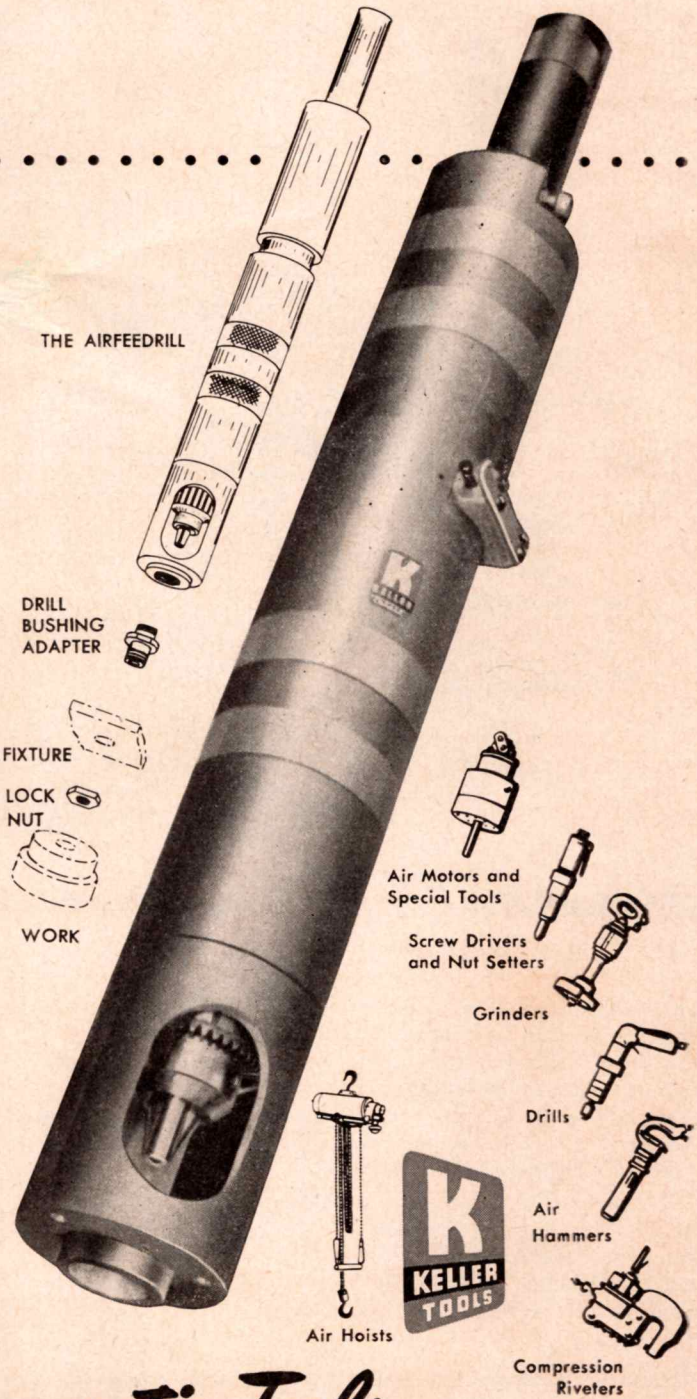
Drilling is entirely automatic. Feed may be regulated to suit conditions, break-through is velvet smooth. Shut-off can be either manual or automatic. The operator never touches the Airfeedrill during the cutting operation.

Hole lineup can be as accurate as required. Run-out or out of parallelism can be held to tolerances measured in tenths . . . well within the requirements of modern application.

If you have multiple holes to drill and ream and great accuracy is a requirement, investigate what Airfeedrills can do for you.

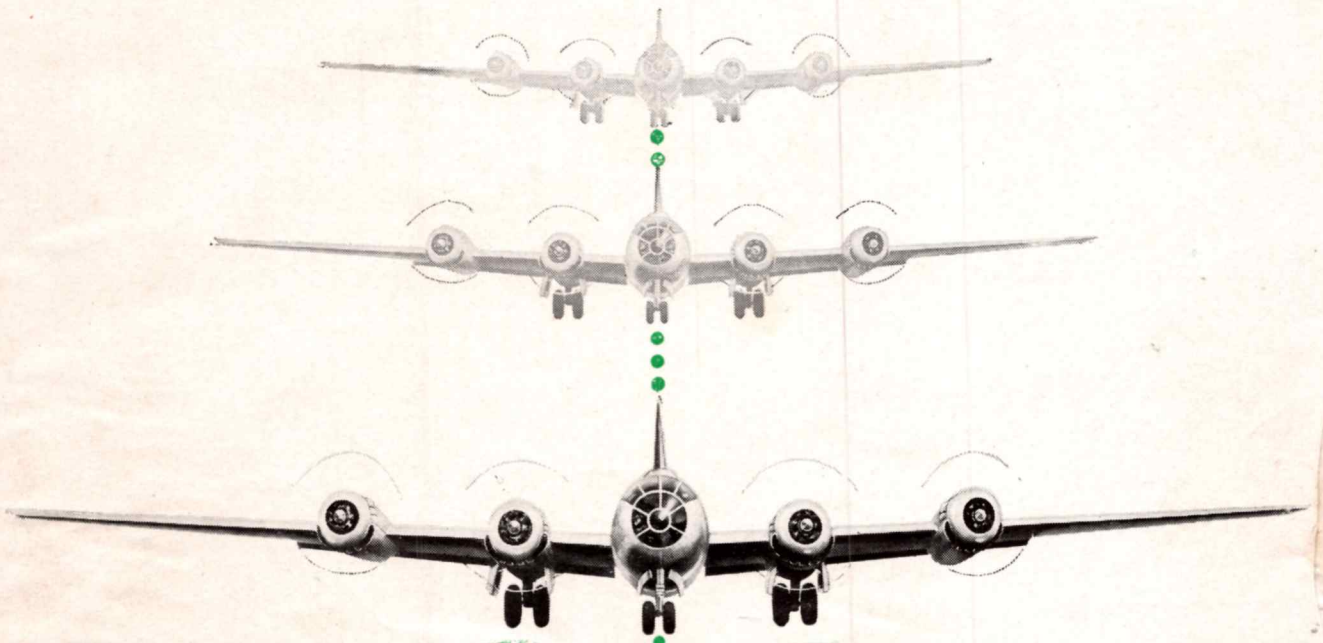
4 great Airfeedrill Advantages

- Easy and economical to set up initially.
- Fixture setups need not be permanent.
- Can often be used in existing fixtures by simply mounting Airfeedrills in bushing holes in fixture.
- Fast and accurate control of stationary drills when equipped with Keller Four-way Air Valves.



Keller Pneumatic Tools

Keller Tool Company, Grand Haven, Mich.



ZERO reader

"thinks" fast for pilots

Sperry's new simplified gyroscopic indicator—the ZERO READER*—is a *fast thinking calculator*. It continuously pieces together attitude, altitude, heading and radio path information and relieves the pilot of complex mental calculations on approaches and landings...simplifies en route flying procedures, leaving more time to devote to other problems vital to the success of his flight plan.

● Sperry introduced the Gyro-Horizon, Directional Gyro, Gyrosyn Compass and Gyropilot. Now Sperry introduces the ZERO READER which is the only manual system approaching the performance of stabilized automatic flight control, another progressive step toward the development of all-weather operations.

● Developed by Sperry with the cooperation and encouragement of All-Weather Flying Division, USAF and the Air Transport Association, the ZERO READER is an example of Sperry's never-ending search for new and better ways to improve flying techniques.

*TRADEMARK—PAT. PENDING

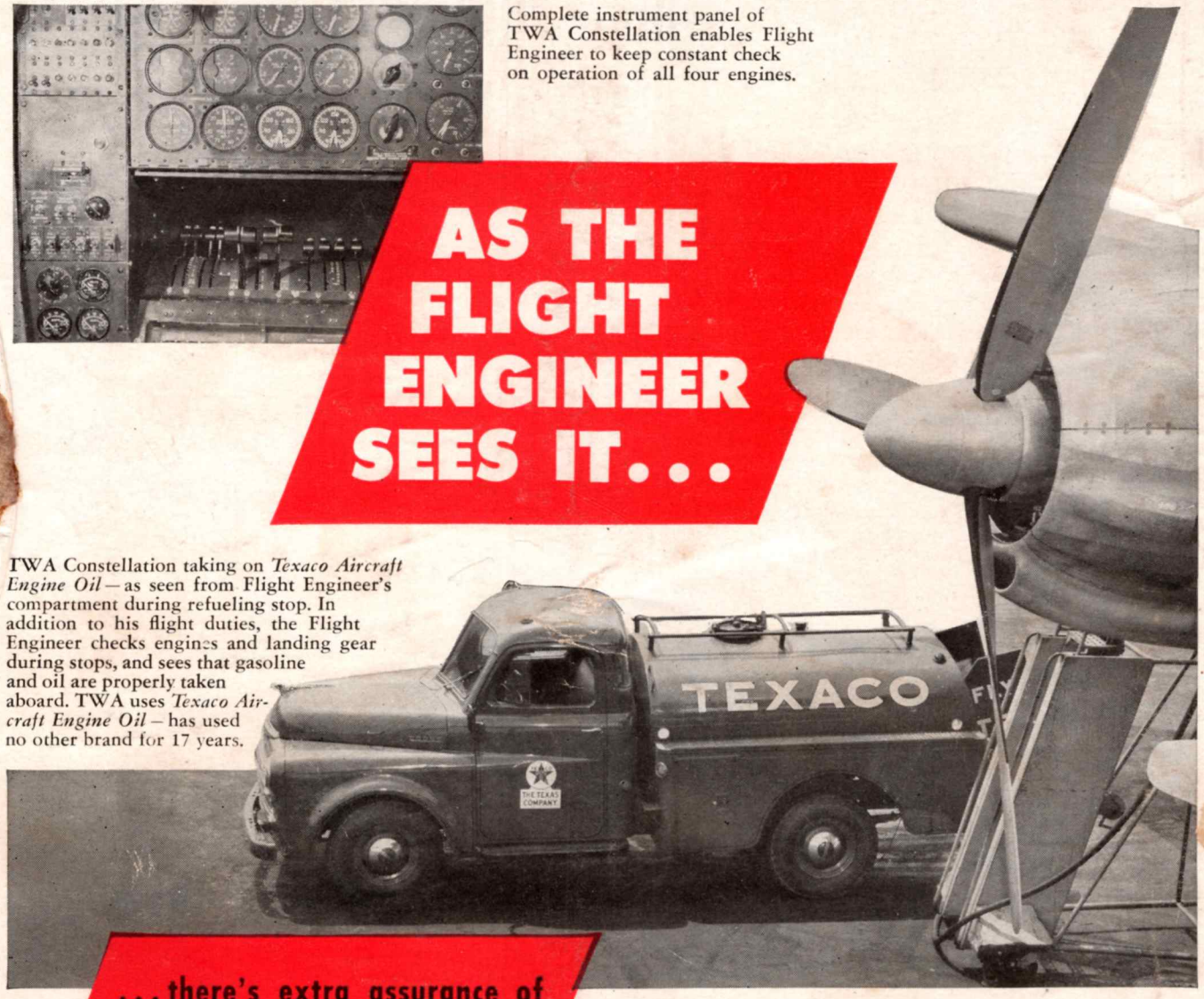
SPERRY GYROSCOPE COMPANY

DIVISION OF THE SPERRY CORPORATION
GREAT NECK, NEW YORK

NEW YORK • CLEVELAND • NEW ORLEANS
LOS ANGELES • SAN FRANCISCO • SEATTLE

Complete instrument panel of TWA Constellation enables Flight Engineer to keep constant check on operation of all four engines.

AS THE FLIGHT ENGINEER SEES IT...



TWA Constellation taking on *Texaco Aircraft Engine Oil* — as seen from Flight Engineer's compartment during refueling stop. In addition to his flight duties, the Flight Engineer checks engines and landing gear during stops, and sees that gasoline and oil are properly taken aboard. TWA uses *Texaco Aircraft Engine Oil* – has used no other brand for 17 years.

...there's extra assurance of dependable performance in TEXACO AVIATION PRODUCTS

Trans World Airline finds it pays to have a Flight Engineer on each of its Constellations. These trained, experienced technicians assure smoother engine operation, lower maintenance costs. And any TWA Flight Engineer will tell you how much help he gets from *Texaco Aircraft Engine Oil* – which the Domestic Division of TWA has been using exclusively for 17 years.

Because it does such an outstanding job, *Texaco Aircraft Engine Oil* is easily America's most preferred aircraft lubricant. As witness the fact that—

More revenue airline miles in the U.S. are flown with Texaco Aircraft Engine Oil than with any other brand.

Another big help for airlines is Texaco Lubrication Engineering Service. Call on it for suggestions on storage and handling of lubricants and fuels, lubrication techniques, and the safest, most efficient maintenance practices for your particular operation.

Just call the nearest of the more than 2,000 Texaco Wholesale Distributing Plants in the 48 States, or write The Texas Company, *Aviation Division,* 135 East 42nd St., New York 17, N. Y.

TEXACO

TEXACO Lubricants and Fuels

FOR THE AVIATION INDUSTRY

TEXACO presents MILTON BERLE on television every Tuesday night. METROPOLITAN OPERA radio broadcasts every Saturday afternoon.